



# The American Journal of Surgery

PUBLISHED MONTHLY BY THE AMERICAN JOURNAL OF SURGERY, INC.

49 WEST 45TH STREET, NEW YORK 19, N. Y.

Editor: THURSTON SCOTT WELTON, M.D., NEW YORK

## EDITORIAL BOARD

CARL BECK, Chicago; CLAUDE S. BECK, Clev.; GEO. R. BRIGHTON, N.Y.; MEREDITH F. CAMPBELL, N.Y.; JAMES T. CASE, Chicago; ISIDORE COHN, N.O.; BRADLEY L. COLEY, N.Y.; FREDERICK A. COLLIER, Ann Arbor; PAUL C. COLONNA, Phila.; ELLIOTT C. CUTLER, Boston; CHARLES A. ELSBERG, N.Y.; HERBERT C. FETT, Brooklyn; JOHN H. GIBBON, Phila.; EMIL GOETSCH, Brooklyn; CHARLES A. GORDON, Brooklyn; DONALD GUTHRIE, Sayre, Pa.; A. E. HERTZLER, Kansas City; LOUIS J. HIRSCHMAN, Detroit; J. M. HITZROT, N.Y.; FREDERICK C. HOLDEN, N.Y.; EMILE F. HOLMAN, San Francisco; ARNOLD S. JACKSON, Madison, Wis.; JOHN E. JENNINGS, Brooklyn; W. L. KELLER, Washington; T. J. KIRWIN, N.Y.; ARTHUR KRIDA, N.Y.; A. V. S. LAMBERT, N.Y.; MAURICE LENZ, N.Y.; H. H. LYLE, N.Y.; JEROME M. LYNCH, N.Y.; URBAN MAES, N.O.; HARRISON S. MARTLAND, Newark, N.J.; RUDOLPH MATAS, N.O.; ROY D. MCCLURE, Detroit; H. C. NAFFZIGER, San Francisco; EMIL NOVAK, Balt.; CLARENCE R. O'CROWLEY, Newark, N.J.; LOUIS E. PHANEUF, Boston; EUGENE H. POOL, N.Y.; JAMES T. PRIESTLEY, Rochester, Minn.; DOUGLAS QUICK, N.Y.; N. P. RATHBUN, Brooklyn; HUBERT A. ROYSTER, Raleigh; HENRY S. RUTH, Phila.; M. G. SEELIG, St. Louis; J. BENTLEY SQUIER, N.Y.; H. J. STANDER, N.Y.; GRANT E. WARD, Baltimore; J. H. WOOLSEY, San Francisco.

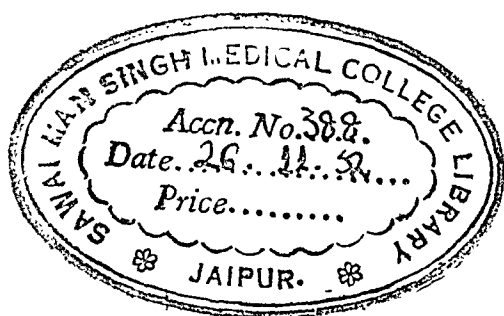
NEW SERIES, VOLUME LXIX

JULY TO SEPTEMBER

1945

THE AMERICAN JOURNAL OF SURGERY, INC., PUBLISHERS  
NEW YORK MCMXLV

COPYRIGHT, 1945  
By THE AMERICAN JOURNAL OF SURGERY, INC.  
*All Rights Reserved*



*Printed in the United States of America*

# CONTENTS OF NEW SERIES, VOLUME LXIX

## ORIGINAL ARTICLES

Allantoin-Sulfanilamide Ointment in Surgery . . .	{ <i>S. Dale Spotts</i> . . . . <i>Joseph B. Davis</i> . . . . }	4
Carotid Body Tumors. Review of the Literature with Report of Two Cases. . . . .	{ <i>Arthur M. Dickinson</i> . . . <i>Clarence A. Traver</i> . . . }	9
Cancer of the Breast. End Results in One Hundred Twenty-two Cases . . . . .	<i>James G. Garland</i> . . . .	17
Dermoplasty of War Wounds of the Lower Leg. . .	<i>Major John F. Pick</i> . . . .	25
Anatomical and Functional Reductions of Fractures of the Pelvis . . . . .	<i>F. Walter Carruthers</i> . . .	39
Evolution of Gastrostomy . . . . .	<i>Julius L. Spivack</i> . . . .	47
Early Extirpation of the Uterus in Persistent Atony with Postpartum Hemorrhage . . . . .	{ <i>Harris M. Rabinowitz</i> . . . <i>Nathan Reibstein</i> . . . }	66
Working Basis for the Treatment of Head Injuries.	<i>Theodore L. Hyde</i> . . . .	73
Healing Rate of Human Skin Determined by Meas- urement of the Electrical Potential of Experimen- tal Abrasions. A Study of Treatment with Petro- latum and with Petrolatum Containing Yeast and Liver Extracts. . . . .	<i>T. Cunliffe Barnes</i> . . . .	82
Operating Room Explosions . . . . .	{ <i>Rickey L. Waugh</i> . . . . <i>Lula Bond</i> . . . . }	89
The Tourniquet. Its Clinical Application . . . .	<i>Robert T. McElvenny</i> . . .	94
Normal Physiological Douches . . . . .	<i>Karl John Karnaky</i> . . . .	107
Clinical Value of Functional Liver Tests . . . .	<i>Abraham O. Wilensky</i> . . .	116
Ligation of the Inferior Vena Cava for Pneumonic Thrombophlebitis . . . . .	{ <i>Howard M. Kern</i> . . . . <i>Edgar Berman</i> . . . . }	120
Double Uterus . . . . .	<i>John J. Vallone</i> . . . .	126
Isolated Myeloma in a Fourteen Year Old Boy . .	<i>Justus Kaufman</i> . . . .	129
Hemangioma of Tendon . . . . .	<i>A. M. Arkin</i> . . . . .	133
Primary Fibrosarcoma of the Great Omentum . .	{ <i>Richard H. Lawler</i> . . . . <i>Paul F. Fox</i> . . . . <i>Harold Cohen</i> . . . . }	135
Wound Disruption Following Cotton Sutures . .	<i>Vincente D'Ingianni</i> . . .	137



A Peritoneal Clamp. Its Use in Fifty Cases . . . . .	{Robert F. Barber . . . . . R. Robert De Nicola . . . . .}	138
Plastic Surgery of Nasal Fractures . . . . .	Edward S. Lamont . . . . .	144
Bilateral Nummiform Fibromyomas of the Nipples with Unilateral Fibromyoma and Papilloma Mamillae . . . . .	{John J. Cunningham . . . . . Samuel E. Cohen . . . . . John R. Cunningham . . . . .}	155
Surgical Management of Substernal and Intra- thoracic Goiter . . . . .	{Alexander W. Blain . . . . . Albert DeMatteis . . . . .}	160
Skin Grafting in Moribund Burned Patients . . . . .	Lester W. Eisenstodt . . . . .	168
Technic of Continuous Pentothal Anesthesia . . . . .	Captain N. B. Kornfield . . . . .	177
Inguinal Herniorrhaphy . . . . .	Theodore L. Hyde . . . . .	182
Treatment of Pulmonary Embolism . . . . .	Major Lewis S. Pilcher . . . . .	190
Relative Efficacy of Penicillin, Tyrothricin, Strepto- thricin and Sulfathiazole on Hemolytic Strepto- coccus in Wounds of Rabbits . . . . .	{Erwin Neter . . . . . Roger S. Hubbard . . . . . Thomas G. Lamberti . . . . .}	204
Use and Abuse of Cesarean Section . . . . .	Edward G. Waters . . . . .	208
Fractures of the Acetabulum . . . . .	{W. Russell MacAusland . . . . . Harold G. Lee . . . . .}	213
Paget's Disease of the Nipple . . . . .	Justus Kaufman . . . . .	221
Asymptomatic Pyuria in Young Men . . . . .	Lieut. Francis A. Beneventi . . . . .	224
Ethyl Alcohol Intravenously as Postoperative Seda- tive . . . . .	R. J. Behan . . . . .	227
Ambulant Method for the Treatment of Pilonidal Disease. A Preliminary Report . . . . .	J. L. Mathesheimer . . . . .	230
Undescended Testicle . . . . .	Millard S. Rosenblatt . . . . .	232
Procedure for Preventing Wound Contamination during Appendectomy . . . . .	Bernard J. Ficarra . . . . .	234
Healing of Pathological Fractures through Metas- tases from Carcinoma of the Breast . . . . .	{Frederic W. Bancroft . . . . . John M. Beal . . . . .}	236
Intrapelvic Protrusion of the Acetabuli . . . . .	Captain J. C. Thoroughbman . . . . .	238
Infected Urachal Cysts . . . . .	Nathan Brodie . . . . .	243
Squamous Cell Carcinoma of the Renal Pelvis . . . . .	{Charles J. E. Kickham . . . . . Lieut. Richard H. Stanton . . . . .}	249
Megacolon. With a Brief Review of Etiological Fac- tors and Treatment . . . . .	{Hugh A. Bailey . . . . . Josef J. Haber . . . . .}	253

Bladder Herniation and Kidney Stone . . . . .	{Channing W. Barrett . . . . . Russell A. Barrett . . . . .}	258
Supravesical Internal Hernia . . . . .	Wendell Downing . . . . .	260
Pendulous Abdomen. Its Surgical Correction . . . . .	A. Sampolinski . . . . .	262
Multiple Primary Malignancy . . . . .	Charles Goldman . . . . .	265
Fracture Dislocation of the Fifth Cervical Vertebrae . . . . .	Lieut. Leon D. Star . . . . .	270
Liver Embolus Following Hemorrhoidectomy . . . . .	{E. G. Martin . . . . . J. F. Wenzel . . . . .}	272
American Surgery. The First Hundred Years . . . . .	Frederick A. Pizzi . . . . .	274
Problem of Delayed Union and Non-union of Frac- tures . . . . .	{Capt. H. C. Fett . . . . . Lt. Comdr. R. F. Foote . . . . . Lt. Comdr. M. A. L. Stevens}	283
Glass Plastic Cast . . . . .	{Roger Anderson . . . . . Herbert R. Erickson . . . . .}	299
Metallic Foreign Bodies and the Electromagnetic Locator . . . . .	John J. Moorhead . . . . .	306
Embedment of a Vitallium Mandibular Prosthesis as an Integral Part of the Operation for Removal of an Adamantinoma . . . . .	{Leo Winter . . . . . Jacob C. Lifton . . . . . Arthur S. McQuillan . . . . .}	318
Thyroid Crisis. Pathogenesis of Hepatic Origin . . . . .	{Bernard J. Ficarra . . . . . Emil A. Naclerio . . . . .}	325
Fibromatous Skin Lesions Produced by Repeated Blood Serum Injections in the Human. . . . .	Wallace Marshall . . . . .	338
Dissecting Aneurysm of the Thoracic Aorta Due to Trauma . . . . .	Donald W. Leonard . . . . .	344
Use of Whole Skin Grafts as a Substitute for Fascial Sutures in the Treatment of Hernias. Preliminary Report . . . . .	George B. Mair . . . . .	352
Operative Cure of Inguinal Hernia in Infancy and Childhood . . . . .	Jerome S. Coles . . . . .	366
Primary Malignant Disease of the Small Intestine . . . . .	{Thomas A. Shallow . . . . . Sherman A. Eger . . . . . James B. Carty . . . . .}	372
Surgical Management of Large Tumors of the Neck. Report of Two Unusual Cases . . . . .	{Claude F. Dixon . . . . . Raymond E. Benson . . . . .}	384
Penicillin Treatment of Gas Gangrene . . . . .	{C. M. Harris . . . . . L. R. Leviton . . . . .}	391

Primary Actinomycosis of the Lung. With Secondary Involvement of the Kidney and Brain Presenting Abnormal Pulse and Temperature Reactions . . .	<i>Harry E. Kasten</i> . . . .	397
Longitudinal Fracture of the Head of the Femur Associated with Dislocation of the Femur. . . .	<i>S. L. Haas</i> . . . . .	402
Fatal Peritonitis from Proctosalpingostomic Fistula Complicating Lymphopathia Venereum . . . .	<i>(Major Alexander E. Pearce.)</i> <i>John O. Bower</i> . . . . . <i>John C. Burns</i> . . . . .	406
Stab Wound of the Heart. Successful Repair of a Laceration of the Heart in a Patient with Aortic Regurgitation and Marked Cardiac Hypertrophy . . . .	<i>J. Hersb</i> . . . . .	409

---

---

# The American Journal of Surgery

Copyright, 1945 by The American Journal of Surgery, Inc.

A PRACTICAL JOURNAL BUILT ON MERIT

*Fifty-fourth Year of Continuous Publication*

NEW SERIES VOL. LXIX

JULY, 1945

NUMBER ONE

---

## Editorial

### PSYCHOLOGICAL ASPECTS OF GYNECOLOGICAL PRACTICE

IN the management of gynecological patients one must bear constantly in mind that one deals with individuals who possess not only the distinctive female anatomic characters, but who present also certain characteristic biological attributes, as well as individual psychological traits. This rather platitudinous generalization can be applied also, though perhaps with less obviousness, to the practice of other specialties than gynecology.

As to the special biological characteristics of woman, certainly no one can say that these are being altogether neglected in these halcyon days of endocrinology and organotherapy. From a purely physiological and endocrinological standpoint, the reproductive phenomena of the human female are pretty much the same as those observed in the primate monkey. There is, however, one important difference, and that is the higher degree of cerebral development in the human, implying a far higher development of that intangible factor which we speak of as the psyche. The dictionary defines the psyche as "the human soul; originally, the vital principle, which constitutes the inner spring of action and development; later, the spiritual being as distinct from the body, both in nature and in destiny; also, the mind, the mental life of an individual, comprising intellectual, emotional, and

impulsive activities and predispositions; the self."

The physician, therefore, is called upon to treat not merely female animals, but animals possessing and permeated by minds and souls. To carry this thought further, the gynecologists' patients are female animals with female minds and souls. No physician, much less the psychiatrist, need be told that many human ailments represent disorders of the psyche rather than of animal structure and mechanisms, but he knows, too, that the animal mechanisms can be profoundly disturbed by primarily psychic disorders.

The brilliant advances made since the early years of the present century in the field of endocrinology have probably led us into an unwarranted mechanistic altitude in the explanations of reproductive phenomena and functional disorders. We try to explain everything by invoking the endocrines, forgetting that the endocrine system represents only a primitive nervous system, a survival in the highly developed human organism of a primitive stage-coach means of intercommunication between various tissues and organs. Of this primitive nervous system the pituitary appears to be the brain, but there is undoubtedly a close liason between this primitive brain and its various auxiliary ductless gland outposts on the one hand, and the brain,

cerebrospinal, sympathetic and autonomic nerve systems on the other.

We know little enough as to the nature of these interlocking mechanisms, but, they are attested by many functional disorders, especially in the field of gynecology. The possible role of psychic and emotional factors is manifested in the production of amenorrhea by severe fright and shock, as seen, for example, in women during the recent bombings of London (Loeser). Cessation of menstruation may also occur through fear and apprehensiveness concerning the possibility of pregnancy, or on the other hand, it may at times be noted in the case of non-pregnant women intensely anxious for motherhood. Menstrual excess may likewise be produced by severe emotional factors, while the importance of the psychogenic factor in the production or exaggeration of many cases of primary dysmenorrhea will be admitted by all gynecologists, however they may differ as to its incidence.

As for the menopause, it is scarcely necessary to emphasize the important role often played by the psyche at this epoch. The wrong ideas so widely prevalent among women as to the significance of the menopause lead many of them to dread its approach, engendering not infrequently a whole train of neuropsychic symptoms of one sort or another. Furthermore, the genuinely menopausal symptoms, the vasomotor flushes and sweats, are often greatly exaggerated under the influence of worry and emotional upsets. Here there is a great field for psychological evaluation and management on the part of the physician.

The growing importance of "nerves," meaning the psyche, in our present war-torn world, must have been noted by every practitioner of medicine in any field. The gynecologist deals with women who are often fighting as severe and trying a battle at home as their husbands and sons are doing on the far-flung theatres of actual combat. Many a harried wife and mother is under stress and strain to keep things going while her bread-winners are

away, not to speak of the intense worry as to the personal safety of the absent soldiers. This one factor alone is encountered almost daily in every gynecologist's consulting room, and it should always be envisaged in the evaluation of the diagnosis and management of such a patient's problem.

Nor is the obstetrician immune from such problems in these days. Many a couple who have previously deferred parenthood have apparently become intensely anxious to get a baby started before the husband goes overseas. It almost seems in some cases that the husband wishes to leave a little replica of himself behind should he fail to return, and the wife is an eager accessory in this ambition. On the other hand, there are other wives in whom profound psychological upsets are due to the fear of having a baby while the husband is away, with the later responsibilities of its upbringing should the father be absent for years or forever.

In many other guises does "dis ole debbil," the psyche, creep into the consulting room. Before the ailing woman betakes herself to the doctor, she is likely to have formed certain preconceptions as to what might possibly be wrong with her. If she has pains in the lower abdomen, she may have decided for herself that she is probably suffering from some disease of the ovaries. If she has backache, it may be a displacement of the womb which she suspects; with almost any symptom she is apt to fear that she is developing a cancer, especially if a close friend or relative has recently died of the disease; and innumerable such examples might be stated. Often the examination does reveal some abnormality, though not always or usually that which the patient had feared. The point is that it is well for the physician to know what particular fear has built its nest in the patient's mind, as he is then in a position to help her along both positive and negative lines.

Every gynecologist must be impressed with the wide prevalence of cancerphobia

among his women patients. There can be nothing but praise and commendation for the woman intelligent enough to seek examination promptly when she notes untoward symptoms of any kind. On the other hand, there are many who avoid and fear examination for long periods, until a real cancer obsession is engendered which at times becomes genuinely psychopathic. When such patients finally drag themselves to the doctor, or are dragged there by a distracted husband, the physician can render a genuinely human service by the exercise of a patient understanding and sympathy. Such patients have often suffered for many months a mental agony far worse than the physical suffering of actual cancer. Simple ridicule of the patient's fears will accomplish little. She must be taken seriously, not only because she may actually have a serious malady, but because only after careful examination, reinforced by simple but convincing explanations and reassurance, can she be sent on her way rejoicing.

The more intelligent the woman the easier the doctor's job in this respect; but even in those of a more ignorant type, the doctor can usually root out the fears which have obsessed the patient. With his reassurance the physician can often combine a valuable individual education as to what the really suspicious symptoms of cancer are, and the importance of seeking advice should such symptoms ever occur. The fear of cancer is so widespread among women that a physician can diffuse much sunshine each year by reassuring patients when this is justified by the findings. It is even possible that he may in this way add more to the sum total of happiness than he can by recognizing and treating the cases of actual cancer which he encounters all too frequently, with usually none too happy a final outcome.

I have chosen the example of cancer, from many which might be mentioned, by way of emphasizing that the gynecologist must be something of a psychologist and at times even a psychiatrist in order to render

full service to his patients. In his practice he will encounter innumerable anxiety-neuroses, phobias and other types of functional psychoneurosis, sometimes quite obvious, sometimes hidden beneath the surface.

The psychological factor is rarely more important than in the case of patients facing serious operations. Even sensible and phlegmatic individuals are quite sure to do a lot of thinking about impending operations, with fears as to what may be found at operation, whether or not they will awaken from the anesthetic, or as to all sorts of possible eventualities. A surgeon would be rather callous if he simply ordered the patient to a hospital for operation with no word of explanation or reassurance. She would have a perfect right to resent such an attitude, and it would not be a good preparation for her ordeal.

Similarly, the surgeon's postoperative visits can often do far more good than medicaments. In the early postoperative days the patient is apt to be pretty miserable and she may cherish misgivings as to whether she will make the grade, and, for that matter, the surgeon may share in these misgivings. But any doubts he himself may entertain should not be communicated to the patient; and even in grave cases, he should make a studied effort to imbue the patient with an optimism which he himself may not feel. If, when the patient is in the depths of apprehension, he begins to tell her what she is to do after she leaves the hospital, she soon takes it for granted that she will actually leave the hospital on the road to recovery, and such a mental attitude is fine medicine for her.

Volumes might be written about the general subject which has here been so tritely and sketchily touched upon. The whole matter boils down to the old injunction that the wise doctor does not treat the disease but the patient. The incentive for this editorial was simply to emphasize that the psyche is a very, very important part of the patient.

EMIL NOVAK, M.D.

---

---

# Original Articles

---

## ALLANTOIN-SULFANILAMIDE OINTMENT IN SURGERY\*

S. DALE SPOTTS, M.D.  
Surgeon, Philadelphia General Hospital

AND

JOSEPH B. DAVIS, M.D.  
Associate in Surgery, Philadelphia General Hospital

PHILADELPHIA, PENNSYLVANIA

THE number of conditions for which the sulfonamides have been used is legion. The introduction of the sulfonamides as prophylactic and therapeutic agents marked the beginning of a new era in surgery and medicine. This can be credited, as far as the English speaking countries, especially England and this country are concerned, to the investigative work and early reports of Colebrook and Kenny,<sup>1</sup> and Long and Bliss.<sup>2</sup>

Since the introduction of the sulfonamides, it appears that too much reliance has been placed on these drugs alone in surgery. It should be borne in mind that these or any other drugs cannot be regarded as substitutes for good surgical procedure. The success of sulfonamide therapy is dependent at all times upon efficient and sound surgical practice.

In the topical application of sulfonamides, local cleanliness and careful débridement of devitalized tissues are of extreme importance. Lockwood<sup>3</sup> has shown that necrotic material or pus contain sulfonamide inhibitors, hence every effort should be made to eliminate or neutralize these substances before sulfonamide therapy is instituted.

Experience has shown that though excellent results were obtained by the oral and parenteral administration of sulfonamides in the control and treatment of systemic infections, these methods were not always effective in the treatment of local suppurative lesions. Installation of sulfanilamide powder into wounds after thorough débridement was reported by

Jensen et al.<sup>4</sup> who treated thirty-nine patients with fractures and obtained primary healing in all of them. They found that sufficient sulfanilamide powder could be placed into a wound to give a high local concentration without causing damage to tissues or producing toxic systemic effects. Key et al.<sup>5</sup> demonstrated that saturated solutions of sulfanilamide or the implantation of the powder in a wound did not seriously damage tissues or interfere with wound healing.

Baker<sup>6</sup> reported that the incidence of infection occurring despite sulfonamide therapy did not coincide with the degree of injury. He stated: "Apparently in many of the cases the presence of infection is due to lack of proper débridement and the lack of restoration of wound anatomical relationship, rather than to the type of injury or the drug used. The presence of a small amount of sulfanilamide is of assistance in abating infection."

We are in complete accord with Key<sup>7</sup> that the placing of one or more of the sulfonamide drugs in a clean operative wound is not a positive assurance against infection, and that the instillation of the drug does not warrant any letting down in the principles of good surgical practice.

In making a choice of the sulfonamide for topical application the diffusibility and solubility of the drug are to be considered, since effective results in the prophylaxis and treatment of wound infections are dependent, in addition to sound surgical principles, on these factors.

\* From the Surgical Service of Dr. S. Dale Spotts, Philadelphia General Hospital.

Hawking<sup>8</sup> has shown that sulfanilamide diffuses rapidly through living tissue and fairly well through dead tissue. The mere placing of a drug in a wound is not enough; it must enter into solution quickly in a fairly high concentration and penetrate all portions of the wound as stressed by Graves,<sup>9</sup> who found that sulfanilamide goes into solution very quickly and in very strong concentration.

After a comprehensive review of experimental and clinical reports, Long<sup>10</sup> concluded that when all factors have been considered, sulfanilamide appears as the drug of choice for the prophylaxis and treatment of contaminated and infected wounds.

Our experience with sulfonamides used topically demonstrated that the incidence of infection in traumatic and surgical wounds was considerably reduced, but, we had to contend with several factors considered objectionable to the use of sulfonamide powders and crystals. We found, in larger wounds, when it was necessary to instill enough of the sulfonamide powder to control infection, "caking" invariably occurred, and, in a number of instances these caked masses produced the effects of foreign bodies. When prolonged application of the sulfonamide powder was necessary, the wound tended to heal slowly, indicating interference with the formation of new granulation tissues. There is no doubt that the tendency to diminish the secretions in an infected wound must retard its healing, and in our experience, the sulfonamides, either powdered or in solution, definitely demonstrated this tendency.

We became interested in the reports of Veal and Klepser<sup>11,12,13</sup> that a combination of allantoin 2 per cent, and sulfanilamide 10 per cent in a specially developed, non-greasy, water-miscible base made up of glycerin, triethenolamine, stearic acid and water,\* controlled infection and at the same time stimulated the formation of

healthy granulations. In demonstrating that this ointment prevented reinfection and hastened healing, they stated: "The substitution of allantoin-sulfanilamide ointment for the pure powder allows a prompt resumption of the normal healing process and at the same time maintains a clean wound."

Allantoin presents an interesting history in regards to its action as a stimulator of tissue growth. Macalister<sup>14</sup> found that extracts of comfrey root contained relatively high percentages of allantoin. He used both the crude extracts of comfrey root and solutions of pure allantoin to treat chronic topical ulcers which had failed to respond to all other types of therapy, and became convinced of the efficacy of these preparations.

The therapeutic application of maggot therapy as suggested by Baer<sup>15</sup> revealed exceptional results in the rapidity of healing and in the increase of healthy granulation tissue. Robinson<sup>16</sup> showed that allantoin, present in the excretion of maggots, was responsible for the healing action.

The successful use of allantoin was reported by Kaplan<sup>17</sup> who concluded: "allantoin induces healing by stimulating healthy granulations and removing necrotic material; treatment is painless; it acts locally as long as allantoin is in contact with the wound."

The successful treatment of osteomyelitis of the mandible was reported by Gordon.<sup>18</sup> Treatment consisted of hourly irrigations with allantoin; healing set in, the entire treatment was ambulatory and proved entirely beneficial to the patient.

We have treated in the past year over one hundred patients with allantoin-sulfanilamide in a specially developed ointment base. These cases included traumatic wounds, leg ulcers, postoperative wound infections, carbuncles, frost bite, decubitus ulcers and infected burns.

Experience has taught us that the best insurance against infection in traumatic wounds was early débridement which

\* Allantomide Ointment was supplied by The National Drug Company, Philadelphia, Pa.



should be as thorough as possible without damage to major nerve or vascular structures, followed by the use of allantoin-sulfanilamide ointment. After the wound had been thoroughly débrided, and cleaned, a liberal amount of the ointment was applied, covered with vaseline gauze, then with a dry dressing. The first dressing was changed after five days. The dressings were removed and the wound cleansed with hydrogen peroxide by gentle swabbing so as not to disturb new islands of granulation present. Fresh ointment was applied, covered with vaseline gauze, then a dry dressing. This was repeated at three-day intervals until healing was complete.

Once healing was underway we noted that an unusual amount of exudate was found in most cases. At times this required changing the dressings ahead of schedule. Similar findings were not observed in those patients on whom powdered sulfonamides were used, and, in a limited degree they were noted in those patients on whom 2 per cent allantoin ointment in a specially developed water-miscible base was used. Definitely, the combination of allantoin 2 per cent and sulfanilamide 10 per cent in a water-miscible base was more effective in this respect. We are of the opinion that this ointment was an important factor in giving us the excellent clinical results we obtained, since an increased lymphorrhea is most essential for favorable wound healing.

In the treatment of burns, first attention was given to the treatment of shock by administration of plasma and the restoration of chemical balance. When this phase was under control, the burned area was carefully cleansed and necrotic tissue removed. The allantoin-sulfanilamide ointment was applied, covered with vaseline gauze dressing, then with pads, and so bandaged as to produce a moderate and even pressure over the area. When possible, splinting of the part was performed to give firm support. Our practice was similar to that of Marshall<sup>19</sup> who kept the dressing on for one week before changing.

At the first change of the dressing, the area was gently washed with hydrogen peroxide to remove all adherent ointment, fresh ointment was applied to cover the wound, and the latter was dressed as previously described. The dressings were then changed at weekly intervals until the wound was completely healed. Under this treatment we found that pain usually subsided at the first application of the ointment. Invariably, islands of epithelium, especially in burns of second degree, were noted in various parts of the wound in addition to a very definite marginal epithelization, at the first change of the dressing.

In several of the burn cases, skin grafting was necessary because of the large area involved. These patients were treated for the first phase as described above; the wound was treated with the allantoin-sulfanilamide ointment to control infection and to produce a suitable granulating bed for pinch grafts. The abdomen and thighs were used as donor areas for this purpose.

At the third change of the dressing, the granulating bed was found satisfactory for placing of the pinch grafts. After the grafts were placed, the whole area was covered with a thin layer of the allantoin-sulfanilamide ointment which was overlaid with vaseline gauze and soft pads, and bandaged to produce a moderate pressure over the area. The dressings were changed after ten days revealing good takes of the graft, also progressive marginal epithelization. The area was gently cleansed with hydrogen peroxide, fresh allantoin-sulfanilamide ointment was applied and dressed as previously described. The dressings were changed at five-day intervals until healing was complete.

The increased exudate noted above appeared as a contraindication to the use of the allantoin-sulfanilamide ointment in the early treatment of burns. This fear, however, was not substantiated in actual practice. The plasma protein, chloride and carbon dioxide studies revealed that their

FIG. 1



FIG. 1. Case 1. Patient was burned June, 1942. This is appearance of patient on March 16, 1943; allantoin-sulfanilamide ointment treatment started on this date.

FIG. 2. Case 1. Appearance of patient September 29, 1943. Complete healing was manifested October 12, 1943.



FIG. 2

FIG. 3. Case II. Small toe and fifth metatarsal removed June 29, 1943. Allantoin-sulfanilamide ointment started July 6, 1943.



FIG. 3

FIG. 4. Case II. Appearance of wound August 27, 1943. The wound is completely closed, and the patient was discharged.



FIG. 4

FIG. 5. Case III. Treatment of carbuncle on back started with allantoin-sulfanilamide ointment May 26, 1943.



FIG. 5

FIG. 6. Case III. Appearance of lesion July 23, 1943.



FIG. 6

FIG. 7. Case IV. Operative wounds of seven months' duration. Allantoin-sulfanilamide ointment treatment started January 31, 1944.



FIG. 7

FIG. 8. Case IV. Appearance of wound as of March 21, 1944.



FIG. 8



levels were no more difficult to maintain than with other methods of treatment.

Exceptional results were obtained with the ointment in decubitus and leg ulcers. The age and nutritional state of the patient and concurrent and predisposing causes, particularly in cases of decubitus ulcers due to transverse myelitis and other neurologic conditions, contributed to delay or complete failure in healing. However, in no case did the lesion fail to improve, infection decreased, marginal epithelization was stimulated and healthy granulation tissue appeared in every case even if limited in degree.

Radical débridement was not attempted in these cases; the simple cleansing of the wound and removal of slough with forceps and knife as they occurred seemed to suffice. The allantoin-sulfanilamide ointment seemed to remove all slough not removed surgically.

The age of the patient undoubtedly had some influence on the duration of treatment. In the older patients healing was slow, but in these cases the oral administration of 1 gr. thyroid per day in divided doses of  $\frac{1}{2}$  gr. morning and night, accelerated the healing process. This was probably due to the stimulation of the capillary circulation by the thyroid and the localized stimulation of the allantoin. When the infection was controlled with the allantoin-sulfanilamide ointment, a plain 2 per cent allantoin ointment in the same specially prepared, non-greasy, water-miscible base was substituted and applied at three-day intervals until healing was complete.

We experienced no cases in which there was a toxic reaction, either systemic or local, to this ointment. A number of cases were studied in regards to blood levels of sulfanilamide obtained. No relationship was found to exist between the extent of the area of the wound and the absorption of the drug. Levels up to 0.8 mg. per cent were found in a few instances, but most cases revealed no appreciable amount of the drug in the blood stream.

A presentation of four cases out of the series treated indicates the types of cases in which allantoin-sulfanilamide ointment was used:

#### CASE REPORTS

CASE I. M. R., white, female, nine years of age, was burned in June, 1942. The application of allantoin-sulfanilamide ointment was started on March 16, 1943. (Fig. 1.) The right side of the back was grafted with pinch grafts. The application of the ointment was continued at weekly intervals. By September 29, 1943, the back was all healed; only a small area in the right axilla still required treatment. (Fig. 2.) On October 12th, there was complete healing, and the patient was discharged. At no time during allantoin-sulfanilamide ointment therapy did the patient show any toxic manifestations.

CASE II. On June 3, 1943, J. G., a white, male, forty-two years of age, was examined and a diagnosis of cellulitis of right foot was made. On June 29, 1943, the small toe and the fifth metatarsal were removed. The patient refused hospitalization, became ambulatory and was treated in the surgical clinic. On July 6, 1943, the patient made his first visit to the surgical clinic since operation. The wound was filled with maggots, which were removed with ether and forceps. The wound was then cleansed with hydrogen peroxide (Fig. 3) packed with allantoin-sulfanilamide ointment, covered with a vaseline gauze dressing, then a dry dressing. The patient walked out of the clinic without aid of crutch or cane. Due to the patient's insistence in walking on the foot, dressings were changed at two-day intervals. The wound was completely healed on August 27, 1943. (Fig. 4.)

CASE III. E. V., a white, female, fifty-three years old, was admitted to the diabetic service with a large carbuncle on her back. She was operated upon on May 22, 1943. Treatment with allantoin-sulfanilamide ointment was started on May 26, 1943. (Fig. 5.) Dressings were changed at three-day intervals on account of copious exudate. After healing was well started, dressings were changed at weekly intervals. On July 23, 1943, (Fig. 6) healing was nearly complete. Complete healing was apparent on August 18, 1943.

CASE IV. F. S., a colored, female, sixty-six years old, was operated upon on July 7, 1943.

The operative wounds failed to heal, treated with sulfanilamide powder, sulfathiazole packs, zinc peroxide and x-ray. Treatment with allantoin-sulfanilamide ointment was started on January 31, 1944, at which time the wounds appeared anemic, gray, sluggish, with skin edges curled under. (Fig. 7.) The ointment was applied after the attached skin edges had been freed and trimmed and a vaseline gauze covering with a dry dressing was applied over this. This procedure was followed at five-day intervals. On March 21, 1944, the wounds were completely closed. (Fig. 8.)

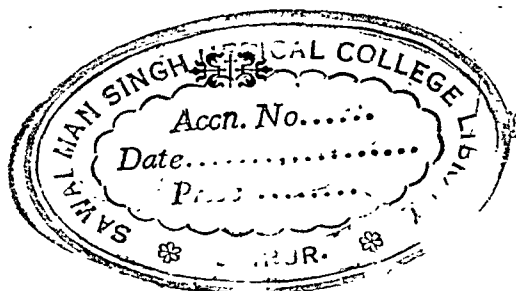
#### SUMMARY AND CONCLUSIONS

The proper preparation of surgical wounds by adequate débridement prior to the application of sulfonamide powders or allantoin-sulfanilamide ointment is strongly stressed. Sulfonamide powder, though controlling infection in wounds, tended to retard healing. The allantoin-sulfanilamide ointment (allantoin 2 per cent, sulfanilamide 10 per cent in a specially developed, non-greasy, water-miscible base) controlled infection and simultaneously increased cellular growth and vascularization of the granulation tissue. Allantoin apparently stimulated granulation and epithelization, while the sulfanilamide manifested a bacteriostatic action. Traumatic wounds, leg ulcers, decubitus ulcers, postoperative wounds with infection, frostbite, infected burns and carbuncles were successfully treated with this allantoin-sulfanilamide ointment in the specially developed, water-miscible base. None of the patients treated with the ointment manifested any reactions. Four case histories from over 100 patients treated are presented.

#### REFERENCES

1. COLEBROOK, L. and KENNY, M. Treatment of human puerperal infections and of experimental infections in mice with prontosil. *Lancet*, 1: 1279, 1936.

2. LONG, P. H. and BLISS, E. A. Para-amino-benzene-sulfonamide and its derivatives: experimental and clinical observations on their use in treatment of beta-hemolytic streptococci infection, preliminary report. *J. A. M. A.*, 108: 32, 1938.
3. LOCKWOOD, J. S. and LYNCH, H. M. Mechanism of action of sulfanilamide: influence of proteolytic products on effectiveness. *J. A. M. A.*, 114: 935, 1940.
4. JENSEN, N. K., JOHNSRUD, L. W. and NELSON, M. C. Local implantation of sulfanilamide in compound fractures. *Surgery*, 6: 1, 1939.
5. KEY, J. A., FRANKEL, C. J. and BURFORD, T. H. The local use of sulfanilamide in various tissues. *J. Bone & Joint Surg.*, 22: 952, 1940.
6. BAKER, L. D. Sulfonamides in traumatic and infected wounds. Report of their use in fresh compound fractures, old compound fractures with infection and chronic osteomyelitis. *J. Bone & Joint Surg.*, 24: 641, 1942.
7. KEY, J. A. Use of sulfonamide in clean operative wounds. *South. M. J.*, 35: 55, 1942.
8. HAWKING, F. Local concentration of sulfonamide compounds inserted into wounds. *Lancet*, 1: 786, 1941.
9. GRAVES, G. Y. The local use of sulfonamides in wounds. *Kentucky M. J.*, 40: 430, 1942.
10. LONG, PERRIN H. Sulfonamide compounds in the prevention and treatment of wound infection. *J. A. M. A.*, 121: 303, 1943.
11. VEAL, J. ROSS and KLEPSE, ROY G. The treatment of pyogenically infected wounds by the topical application of powdered sulfanilamide and sulfanilamide-allantoin ointment. *Med. Ann. District Columbia* 10: 61, 1941.
12. VEAL, J. ROSS and KLEPSE, ROY G. Local sulfanilamide therapy in surgical infections. *Surgery*, 10: 974, 1941.
13. VEAL, J. ROSS and KLEPSE, ROY G. Sulfanilamide therapy in surgery. *South. M. J.*, 36: 292, 1943.
14. MACALISTER, C. J. A new cell proliferant. Its clinical application in the treatment of ulcers. *Brit. M. J.*, 1: 10, 1912.
15. BAER, W. S. The treatment of chronic osteomyelitis with the maggots (the larvae of the blowfly). *J. Bone & Joint Surg.*, 13: 438, 1931.
16. ROBINSON, WM. Stimulation of healing in non-healing wounds by allantoin occurring in maggot secretions and of wide biological distribution. *J. Bone & Joint Surg.*, 17: 267, 1935.
17. KAPLAN, T. The allantoin treatment of ulcers. *J. A. M. A.*, 108: 968, 1937.
18. GORDON, IRVING. Use of allantoin in the treatment of osteomyelitis of the mandible. *Internat. J. Orthodontia*, 23: 840, 1937.
19. MARSHALL, W. and GREENFIELD, ELENA. Modified non-adherent gauze pressure treatment of burns. *Am. J. Surg.*, 63: 324, 1944.



# CAROTID BODY TUMORS

## REVIEW OF THE LITERATURE WITH REPORT OF TWO CASES

ARTHUR M. DICKINSON, M.D.      AND      CLARENCE A. TRAVER, M.D.

Associate Professor of Surgery, Albany Medical College      Assistant Professor of Surgery, Albany Medical College

ALBANY, NEW YORK

THE carotid body or glomus caroticum, first described by von Haller in 1743, is an oval mass of tissue about 5 mm. in length situated just posterior to the bifurcation of the common carotid artery. It is reddish brown in color or grayish brown with a distinct capsule from which fibrous septa extend into its substance to divide it into lobules. It is said to originate from the adventitia of the internal carotid artery according to one theory; others incline to an origin from the epithelium of the pharynx or the embryonic ganglion cells of cervical sympathetic chain. Its histology was beautifully described by Luschka in 1862, and he foresaw that tumors might arise from it. The first verified case of tumor in America was that of Scudder,<sup>1</sup> described in 1903. However, Marchand and Paltauf each independently described a tumor of the carotid body in 1891. Scudder's patient recovered while many of the early patients died of complications or recurrences. About 275 of these cases have now been described in the literature. Few surgeons have operated upon more than two patients due to the rarity of the condition; however, Hertzler<sup>2</sup> reported seven personal cases in 1937.

Chromaffin cells occur in the normal gland and are found in the majority of the tumors. Thus, the carotid body resembles the adrenal medulla, the aortic body, the hypophysis, the coccygeal body and the paravertebral sympathetic ganglia. The chromaffin granules take a brownish stain with chrome salts in fresh tissue and are found in epithelioid cells which have large round or polyhedral shape and a large round nucleus. The chromaffin reaction is not constantly present, however. No in-

ternal secretion has been isolated from the carotid body. The physiological function is not clear but has become confused with that of the carotid sinus. Atrophy of the carotid gland after puberty or in early adult life is the rule.

The carotid sinus is the enlarged portion of the common carotid artery just before it bifurcates into the internal and external carotid arteries. Through its rich nerve supply and connections with the cervical sympathetic system it plays an important rôle in the regulation of the heart rate and the maintenance of blood pressure. Compression of the carotid sinus results in a slowing of the pulse and a fall in blood pressure; pressure applied to the common carotid artery just below the sinus results in the opposite picture, i.e., increase of heart rate and a rise in blood pressure because of reduced pressure in the carotid sinus.<sup>3</sup> The closeness of the carotid body and the carotid sinus explains some of the symptoms attributed to the carotid body tumors which can easily press upon the carotid sinus.

The pathology of the carotid body tumors (peritheliomas) is best described by Ewing<sup>4</sup> in his *Neoplastic Diseases*. They are slowly growing and only occasionally reach large size; the average tumor weighs about 50 Gm. Prompt fixation of fresh tissues is necessary to preserve their structure for microscopic study and if chromaffin granules are to be demonstrated. The epithelioid cells show an alveolar arrangement or lie in compact groups without lumen; the larger groups show necrosis at their centers with cavities filled with blood. Capillaries are also seen and hyaline degeneration within the cells. Endothelial cells as well as perithelial cells

play an important part in most tumors. There are medullated and non-medullated nerve fibers but few ganglion cells are

ratio of 3:2. A familial tendency also was noted by the above authors. The rate of growth of these tumors is slow but many

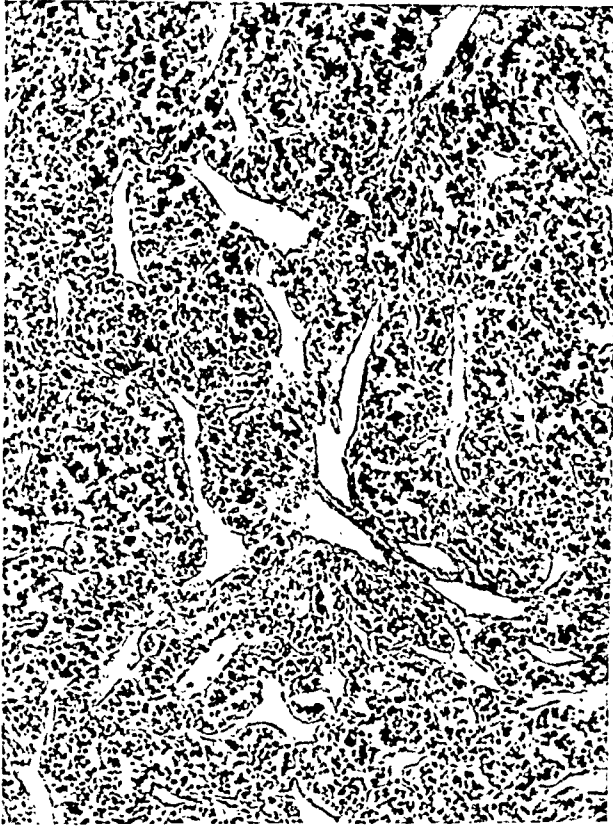


FIG. 1. Case 1. Section of tumor removed at second operation. The large vascular spaces are very evident; note also vacuolated cytoplasm and small nuclei of tumor cells.

present. Giant cells may be found. Recurrence of the tumors, if not completely removed, malignant changes and local metastases should be mentioned, but distant metastases are not well authenticated.

Most tumors of the carotid body have been present for six or seven years before the patients seek surgical treatment. The condition is one of middle life for the most part (90 per cent found between the ages of twenty and sixty years); it is equally common to the two sexes and usually unilateral. Bilateral tumors have been described occurring concomitantly or at various intervals of time by Harrington et al.<sup>5</sup> Some authors have noted a preponderance of left-sided tumors in the

have encircled the carotid vessels before operation is undertaken or have undergone a malignant change; ligation of one or more of the carotid arteries and also the internal jugular vein is usually required. Bevan and McCarthy<sup>6</sup> discuss in some detail the hazard of ligating the common carotid or the internal carotid which is even more likely to produce brain damage. A mortality of 30 per cent is the rule in such cases, and this increases with age and the lessened capabilities of the vascular system to make compensations. Nerve damage at operation also is not unusual as the following are in close proximity to the tumors: glossopharyngeal, hypoglossal (particularly the descending

branch), vagus or recurrent laryngeal branch, superior cervical chain, and phrenic nerve.

In differential diagnosis we must consider most carefully chronic lymphadenitis (especially tuberculous), lymphomas, branchial cyst, branchiogenic carcinoma and metastatic carcinoma, aneurysm, and nodules of aberrant thyroid tissue.

That these tumors are generally benign, at least in the early years of their growth is established, but they tend to recur locally and a secondary operation for a recurrence carries an increased risk to the patient. However, the original operation may be done in two stages if necessary with a short interval of time between, and this seems to make the task less formidable. Distant metastases are rare or doubtful although metastases to local lymph nodes in the neck do occur. When benign, the tumors are well encapsulated; but with the onset of malignancy there is invasion of the capsule and loss of alveolar formation so that the cells grow diffusely. From 15 to 20 per cent are considered malignant. Duration of the tumors has varied from four months to thirty years.

The only constant symptom is a swelling in the neck at the level of the bifurcation of the carotid artery with a lateral mobility, which is slight, and absence of mobility in an up-and-down direction. A transmitted pulsation or "lift," but no bruit, is the rule; at times the tumor seems to get smaller with compression because of its vascularity. There may be tenderness but *per se* the tumor is not painful. Some patients complain of attacks of faintness with lowered blood pressure indicating carotid sinus irritation from pressure. Hoarseness may be present if the vagus or recurrent laryngeal nerve is compressed, and in some patients a Horner's syndrome has been observed. Correct preoperative diagnosis has been made in only a few cases (Peterson and Meeker<sup>7</sup>), but at operation the true situation is readily recognized because of the characteristic location of the tumor at the carotid bifurcation,

its vascularity, and the difficulty of the dissection.

Proper treatment is excision, certainly

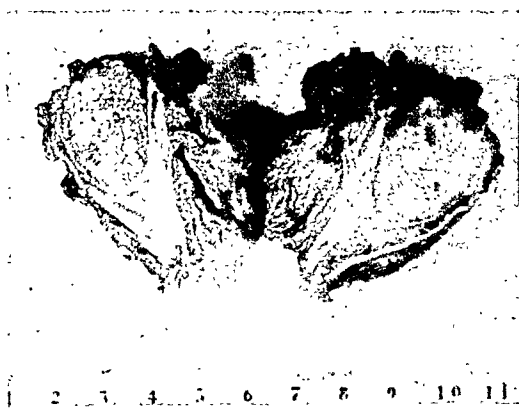


FIG. 2. Case 11. Photograph of gross specimen; note the divided carotid vessels surrounded by tumor.

when the case is seen in the early stages; roentgen therapy, although it has been used, has not established itself as of value. Steady growth is to be expected and pressure symptoms are bound to develop. The longer the delay, the more difficult the operation and the more likely the complications, but some of these can be avoided by careful technic and good anesthesia. In about 50 per cent of the reported cases it has been necessary to sacrifice the common carotid artery, and division of this is followed by changes in the corresponding cerebral hemisphere that result in death in about 30 per cent; about 50 per cent of those that survive will have permanent brain damage. Also the close association of the mass with the phrenic, vagus, hypoglossal and recurrent laryngeal nerves render these structures liable to injury with various permanent defects. In both of the cases reported herewith there was nerve damage of a permanent nature.

Harrington et al.<sup>5</sup> report a mortality of 20 per cent and indicate this was due to hemiplegia for the most part. In the twenty cases reported by him major vessel ligations were required in nine instances. The younger the patient, the better the chance of surviving a ligation. On the other hand, Peterson and Meeker<sup>7</sup> in their report of eighteen cases had no operative



deaths but five of their patients died of recurrences within a period of four years. In this latter series, major ligation was

will increase the collateral blood supply of the corresponding cerebral hemisphere. With the same purpose in mind, some

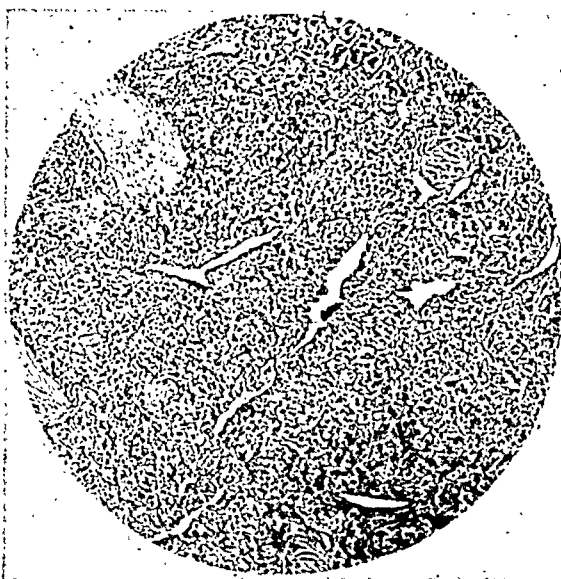


FIG. 3. Case 11. Photomicrograph,  $\times 50$ ; note polygonal shaped cells supported by delicate fibrous stroma growing in cords and pseudo-acini. The cells closely approach large blood channels.



FIG. 4. Case 11. Higher magnification,  $\times 350$  of a section shown in Figure 3 demonstrating the structure of the large polygonal cells; note the abundant, light foamy and often vacuolated cytoplasm and the relatively small compact nuclei. Also observe the close relationship of the cells to the vascular space.

required in seven instances; of these three developed cerebral symptoms such as aphasia, hemiplegia, etc. A total of fifteen had some residual disability resulting from the operation. In a series of four cases reported by Shawan and Owen<sup>8</sup> the carotids were ligated once and resected twice; the facial nerve was injured twice, the right vagus nerve three times, the spinal accessory twice, the hypoglossal nerve twice and the cervical sympathetic system once. There were no deaths from operation, however. Phelps et al.<sup>9</sup> review 159 cases of which 148 were operated upon. The gross mortality rate was 24 per cent. Ligation was necessary in fifty-nine instances; complications followed operation in seven instances and eight showed recurrences of the tumor.

If the diagnosis of carotid body tumor is made before operation, preoperative preparation of the patient is indicated. Essentially, this consists of a period of carotid compression in the hope that this

operators have applied removable bands or ligatures to the common or internal carotid artery. How much this period of preparation accomplishes is open to question. It seems to us very doubtful if collateral circulation of the brain is improved by compression of the carotid artery. In other regions of the body collaterals probably do increase following compression of the main artery but with the limited circulation available in the brain, we question it.

Most often the carotid body tumor is not recognized until exposed at operation. Under these circumstances and without a realization of the seriousness of the situation on the part of the patient or his relatives, it seems wise to limit oneself to a simple biopsy and complete the operation at a later stage.

For radical removal of the tumor a long incision anterior to the sternocleidomastoid is made and the muscle retracted laterally.

Ordinarily the mass is then obvious and dissection can be undertaken. Before attacking the tumor proper it is wise to pass ligatures about the principal vessels so that in the event of a tear exsanguinating hemorrhage can be prevented by traction on the proper ligature. As a rule these tumors surround the carotid artery at its bifurcation to a greater or lesser extent. Generally they are encapsulated but the capsule may be broken through in the event of a previous operation or a malignant degeneration. The mass is very vascular due to many small capillaries which bleed freely during the dissection; usually this can be controlled by hot sponges and pressure. One must not hurry the dissection for haste may result in irreparable damage to vital structures. It seems to us that the easiest method is to dissect out the important vessels and nerves both above and below the tumor and then approach the tumor. Often the vagus or the phrenic nerve passes through the mass and must be carefully dissected out. The same is true of the hypoglossal and recurrent laryngeal nerves. Frequent irrigation of the wound with saline solution prevents drying of tissues and keeps the field clear. In some instances the tumor mass can by careful dissection be separated from the vessels; this may be facilitated by division of the mass into segments which is less of a risk than ligation of the major vessels. In about half of the cases, however, ligation of the major vessels will have to be done to remove the tumor completely. It is well to remember that these large vessels should be ligated with non-absorbable suture material of good size or otherwise fatal postoperative hemorrhage may occur. A transfixion ligature is not so easily dislodged as an ordinary tie and so is recommended. At operation, when it is considered necessary to ligate common or the internal carotid body, the vessel should be carefully compressed for a short time and the patient observed for any obvious reaction before permanent closure is made.

In the immediate postoperative period the patient must be watched carefully. If the recurrent laryngeal nerve has been injured, respirations may be embarrassed; this is helped greatly by the administration of oxygen. Some of the patients will have a painful dysphagia due either to nerve or muscle damage; an indwelling duodenal tube through which the patient can be fed will relieve this materially. The occurrence of a hemiplegia is also an unfortunate complication; these changes may be temporary or permanent. Little can be done to influence the final outcome in such cases. Also an aspiration pneumonitis may occur; the usual treatment and perhaps bronchoscopic suction may be necessary. Secondary hemorrhage should not occur, but if it does, the wound should be opened promptly and the bleeding point secured.

Proper treatment of a recurrence of a malignant tumor requires fine judgment. In some instances, further radical surgery is indicated especially if the primary operation was not complete. In other instances, palliative roentgen therapy may be used.

#### CASE REPORTS

CASE 1. H. D., a woman thirty-eight years old, was admitted to Albany Hospital March 28, 1930, because of a swelling in the right side of the neck just below the angle of the jaw, which was noticed seven years before and had increased in size slowly at first, but for a year past had grown more rapidly. There were no symptoms directly associated with it, but she thought she had been more nervous than usual during the past year and had tired more easily; in addition, she had had frequent respiratory infections. The past history was not significant.

The swelling in the right side of the neck suggested a tuberculous lymphadenitis. It was the size of a hen's egg and situated at the anterior margin of the sternocleidomastoid muscle in the submaxillary triangle. It was not tender and no fluctuation was noted; but the swelling was firm, smooth, and elastic, suggesting a tense cyst. There was no bruit present, and no pulsation was noted except that transmitted from large blood vessels beneath. The thyroid gland was not abnormal to palpation.

No lymph nodes were palpable on the left side of the neck or elsewhere. Examination of the throat as also the rest of the physical examination revealed nothing abnormal. Temperature, pulse, and respiration were normal. Urinalysis and blood Wassermann test were negative, but an x-ray examination of the chest showed accentuation of the lung markings with discrete beading in the right infraclavicular region, suggesting the changes of tuberculosis, probably healed. These findings further influenced us in making a diagnosis of tuberculous cervical lymphadenitis. A branchial cleft cyst was considered in differential diagnosis as a possibility, but Hodgkin's disease and other forms of lymphoma were not seriously considered, and malignant disease did not seem likely.

An excision was performed under ether anesthesia on March 29, 1930. The sternocleidomastoid muscle was exposed through an oblique incision on the right side of the neck and was retracted laterally revealing a vascular tumor 5 by 4 by 3 cm. which, because of its appearance was at first thought to be aberrant thyroid tissue. Exposure was difficult and the tumor could not be lifted from its bed because it was so friable and vascular; but when bleeding was controlled satisfactory exposure was obtained and an encapsulated tumor was found lying in close proximity to the carotid vessels at the point of bifurcation of the common carotid artery. Then the diagnosis of carotid body tumor was suggested at once. As the tumor was fairly well encapsulated, it was finally delivered by blunt dissection. There was a definite pedicle which was crushed and ligated. The carotid arteries were not damaged and so were not ligated, but a branch of the internal jugular vein leading to the tumor was ligated. A gutta percha drain was then inserted and the wound closed in layers. A hematoma formed in the wound but did not materially delay her convalescence. However, she developed a double peritonsillar abscess soon after returning home from the hospital; fortunately the wound healed without infection.

The pathologist reported as follows: "A malignant tumor, very cellular, with moderate number of mitotic figures, probably derived from the carotid body. Diagnosis: tumor of carotid body, perithelioma."

X-ray therapy was not seriously considered at this time because we had an encapsulated

tumor and felt a satisfactory excision had been done. About a year after this operation the patient noticed a small swelling beneath the upper end of the scar, but I did not examine her until November, 1933, which was three and one-half years after the operation of March, 1930. The swelling was then 3 cm. in diameter and close to the angle of the mandible. She was urged to have another excision but refused until September, 1938, when I saw her in a typical attack of acute appendicitis. Appendectomy was performed and during her convalescence I persuaded her to have the recurrent neck tumor, then 5 by 6 cm. in longest diameters, excised. This was done on September 28, 1938, ten days after the appendectomy, under cyclopropane anesthesia after preliminary medication with morphine gr.  $\frac{1}{6}$  and scopolamine gr.  $\frac{1}{150}$ . The second operation was much more difficult than the first as the tumor was now infiltrating and not well encapsulated. Both the internal and external carotid arteries passed through the tumor and were divided between ligatures in the course of the dissection. The tumor extended upward toward the base of the skull between the mastoid process and the ramus of the mandible, and this portion of it was soft and friable, making the dissection here very difficult so a portion of the tumor, perhaps 1 cm. in diameter, was left behind at the upper pole. This bled freely and packing was necessary after an ineffectual attempt to control hemorrhage by a stitch ligature. Her condition following operation was good, and there was no secondary hemorrhage although a hematoma formed as before. She complained of difficulty in swallowing after the second operation and hoarseness which came on gradually and persisted with only moderate improvement. A consultant's examination by indirect laryngoscopy on October 7, 1938, showed paralysis of the right vocal cord which was stationary in the median line and slightly edematous.

The pathological report of the tissue removed at the second operation was in part as follows: The specimen consists of an ovoid mass of soft tissue measuring 5 by 3 by 2.5 cm. Approximately two-thirds of the mass is composed of soft, brownish-gray, neoplastic tissue, fat and muscle. Sections from this tumor show a slowly-growing, fairly well encapsulated neoplasm which has the characteristics of a "carotid body tumor." Mitotic

figures are not found. The entire tumor is generally encapsulated, but here and there neoplastic cells extend outward into the adjacent soft tissues. The most marked invasion is about small nerve fibers in the neighborhood of the growth itself. There is no evidence of invasion of muscle. Small and large blood vessels are abundant, however, this recurrence does not exhibit the marked perithelial arrangement of cells that characterized the growth in 1930. In general the vessels are thin-walled consisting of only endothelium on a delicate fibrous membrane which serves to support it. Hemorrhages are few; lymph nodes in the sections show no tumor metastases.

A recent examination (June 19, 1944) shows her to be in good health with no sign of a recurrence in the neck or elsewhere. Her weight has increased to 143 pounds. She complains of hoarseness increasing with fatigue, a pounding sensation in the left ear, and difficulty on swallowing. These findings indicate nerve damage to the recurrent laryngeal and glossopharyngeal nerves. There is atrophy of the right side of the tongue indicating damage to the hypoglossal nerve and a depressed scar on the right side of the neck extending from the mastoid process obliquely downward two-thirds of the way to the clavicle. The chest and abdomen are normal and there is no lymphadenopathy. The blood pressure is 130/70. She is quite active with household duties and the prognosis seems good.

CASE II. K. C., a male, age thirty-three, entered Memorial Hospital October 20, 1943, complaining of a mass in the right side of his neck of four months' duration. He stated that the mass had slowly increased in size and that it was not painful. Since he had first noticed the mass, he had lost thirty pounds in weight and had been subject to attacks of low blood pressure according to his physician. These attacks were characterized by a sudden feeling of faintness which in some instances caused the patient to fall down; the attacks occurred every three or four days and lasted about an hour. The past history was irrelevant.

Physical examination revealed a tall, thin, pale looking individual. The only positive finding was a mass 5 by 6 cm. located in the right submaxillary region. It was hard, slightly tender and seemed fixed; no pulsation was observed. The usual laboratory studies were made with essentially normal findings.

On October 21st, the mass was explored through an incision along the anterior border of the sternocleidomastoid muscle. After a slow and tedious dissection during which much bleeding occurred, the mass was sufficiently exposed so that it was seen to be surrounding the carotid bifurcation. It was recognized as a probable carotid body tumor and a biopsy done; after this the wound was closed for the operator believed that the patient was not prepared either mentally or physically to subject him to radical resection at that time. The situation was discussed with the family of the patient, and the patient was later instructed to make regular compression of the carotid artery. Eight days later the wound was reopened and enlarged so as to afford adequate exposure for careful dissection. In order to remove the mass it was necessary to ligate the common carotid artery and the internal jugular vein below and both carotids and the vein above. During the dissection the phrenic nerve was carefully separated from the mass in which it was embedded. The vagus nerve was free. The inferior laryngeal nerve was involved and in the dissection was divided; also the hypoglossal nerve was apparently pinched with a forceps for some paralysis of the tongue was noted after operation. Except for some laryngeal stridor during the immediate postoperative period the patient did well and on his tenth day was able to leave the hospital with the incision healed. At that time laryngoscopic examination revealed a partial paralysis of the right vocal cord.

Three months after operation the patient was working again; he had regained all his weight; he still had some hoarseness but no respiratory difficulty, and the paralysis of the tongue had cleared except for the very tip on the right side. He had had no more of the attacks of "low blood pressure" since operation.

The pathological report was as follows: The specimen consists of an irregular mass of soft tissue, 5.4 by 4.5 by 2.7 cm. in size. A large artery passes through the central part of the mass. The artery bifurcates, and the two branches extend around a nodule of soft yellowish gray tissue which contains many hemorrhagic foci. The nodule itself measures 3 by 2 by 2.2 cm. It is relatively well circumscribed. Microscopic examination: Sections show an ovoid tumor surrounded by a collagenous capsule. The tumor is composed of

large polygonal cells with abundant light foamy cytoplasm and round, centrally located basophilic nuclei. The nuclei are relatively regular in size, shape, and staining reaction although a few larger, more deeply staining nuclei are noted. The cells are supported by delicate fibrous trabeculae, separating them into ovoid masses giving a pseudo-acinous appearance. There is no demonstrable neoplasm outside the capsule.

#### CONCLUSIONS

The literature of carotid body tumors has been reviewed and two new cases added.

Carotid body tumors, while by no means rare, are still rather uncommon; to date about 275 cases have been reported.

The most satisfactory method of treatment is surgical removal. Because of the close association of the tumor to vital ves-

sels and nerves radical surgery carries with it considerable risk to life.

#### REFERENCES

1. SCUDDER, C. L. Tumor of intercarotid body. *Am. J. Med. Sc.*, 6: 384, 1903.
2. HERTZLER, A. E. *Surgical Pathology of Diseases of the Neck*. P. 90. Philadelphia, 1937. J. B. Lippincott Co.
3. GRATIOT, J. H. Carotid-body tumors, collective review. *Internat. Abstr. Surg.*, 77: 177, 1943.
4. EWING, JAS. *Neoplastic Disease*. 4th ed., p. 385. Philadelphia, 1940. W. B. Saunders Co.
5. HARRINGTON, S. W., CLAGGETT, O. T. and DOCKERTY, M. B. Tumors of the carotid body. *Ann. Surg.*, 114: 820, 1941.
6. BEAVAN, A. D. and MCCARTHY, E. R. Tumors of the carotid body. *Surg., Gynec. & Obst.*, 49: 764, 1929.
7. PETERSON, E. W. and MEEKER, L. H. Tumors of the carotid body. *Ann. Surg.*, 103: 554, 1936.
8. SHAWAN, H. K. and OWEN, C. J. Carotid body tumors. *Am. J. Surg.*, 40: 462, 1938.
9. PHELPS, F. W., CASE, S. W. and SNYDER, G. A. C. Primary Tumors of the carotid body, review of 159 verified cases. *West. J. Surg.*, 45: 42, 1937.



# CANCER OF THE BREAST\*

## END RESULTS IN ONE HUNDRED TWENTY-TWO CASES

JAMES G. GARLAND, M.D.

Head of Tumor Clinic, Milwaukee County Hospital

MILWAUKEE, WISCONSIN

THIS paper is a ten-year review of 122 consecutive cases of cancer of the breast in women observed at the Milwaukee County Hospital from 1932 to 1941. The purpose of this review is to show the end results and to bring out the necessity of early treatment.

At our Tumor Clinic the patients with breast cancer were roughly classified from the history into (1) primary group, and (2) recurrence. After examination, they were further classified into (A) limited to breast or local only, (B) axillary involvement or regional metastasis, and (C) remote metastasis. The opinion of operability was then noted.

The operating surgeon did a simple or radical mastectomy as his opinion dictated. The pathological report (of the tumor and the accompanying lymph nodes) was forwarded to the Tumor Clinic. When there was no pathological report on the axillary lymph nodes, e.g., where a simple mastectomy was done, the original clinical examination of the axilla determined the classification. This clinical evaluation of the extent of the disease is, we know, subject to some error. Haagensen and Stout point out that only 85 per cent of those with palpable axillary nodes are confirmed as malignant and that 44 per cent are cancerous when no nodes are palpable. Simmons' findings were much the same: 80 per cent and 40 per cent, respectively. But, when no pathological report of the lymph nodes were available, the next best evaluation was a clinical opinion. Table 1 shows the clinical classification.

Of the 122 patients seen with breast cancer, no treatment except palliation was

given in twenty-one; secondary operation, usually with x-ray therapy, was done in twenty-one; and primary mastectomy was done in eighty. Ninety-six mastectomies were done in this entire series by nine different surgeons. The only operative death was in a poor risk patient with advanced cancer.

TABLE I  
ANALYSIS OF BREAST CANCER CASES  
Total number of patients..... 122

Primary	
Disease limited to	
breast.....	36 (30%)
Axilla involved.....	57 (47%)
Remote metastasis.....	8 (7%)
Recurrence (primary treatment elsewhere)	
Local only.....	4 (3%)
Regional.....	10 (7%)
Remote metastasis....	7 (6%)
Number of radical mastectomies.....	80
Number of simple mastectomies.....	16
Operative deaths.....	1 (1.04%)
Inconclusive deaths (death from other causes in less than five years).....	3
No follow up.....	4
Patients followed for end result study...	118 (96.8%)

One hundred eighteen were followed by the Tumor Clinic. An attempt was made to examine these ambulatory patients every month the first postoperative year and every three months thereafter. They often failed to appear. They were then contacted by letter at six-month intervals to return for examination. Two refused treatment and were not seen again. Two could not be located after secondary treatment.

When seen, they were questioned for weakness, chronic pain or chronic cough. Weakness was interpreted as an indication

\* From The Department of Surgery, Milwaukee County Hospital.

of liver or bone metastasis; chronic local pain as an indication of bone metastasis; and chronic cough as an indication of lung

was determined in clinical examination only. Patients who died of intercurrent disease, when clinically free of cancer, were

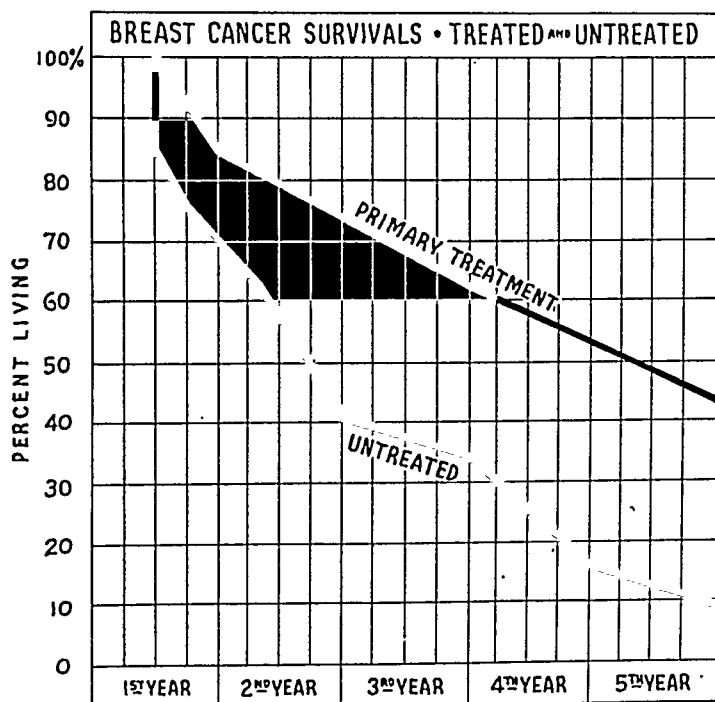


FIG. 1.

metastasis. Physical examination, diagnostic x-ray, sedimentation rate and blood count then followed. Several times a nodule, which was palpable on a rib, would not be seen on x-ray until two or three months later.

In the physical examination, pallor was considered a danger sign of liver or bone metastasis. Function of shoulder and presence or absence of edema of arm were noted. Local recurrence in the operative scar, on the skin of the chest, or in the subcutaneous tissues was looked for. The axillae and supraclavicular areas were palpated for adenopathy. The drain site in the axilla was inspected. The ribs and sternum, as well as the opposite breast and the liver edge, were palpated for abnormality. A complete examination was done if indicated.

Most of the deaths occurred at home after recurrence or metastasis was found. Usually no autopsy was done, so the location of recurrence as noted in this paper

excluded from statistics from the time of their death.

In follow-up, a patient was called a "survival" who was alive with or without cancer, and a "cure" when alive with no clinical evidence of cancer at the time. The term "cure" was used with mental reservation.

#### UNTREATED PATIENTS

There were twenty-one patients who were not treated except with palliative x-ray. Six were operable when first seen. Four of these refused treatment and two suffered from other disease contraindicating surgery. The remainder were inoperable, i.e., not confined to the breast and axilla or not freely movable on the thoracic wall. The average age was fifty-eight years, whereas the average age of the 122 patients was fifty-three years.

Two patients with Paget's disease refused treatment. Of the remaining nineteen, the average life span from their first

symptom to death was 2.7 years. Only 11 per cent of these were living five years after the onset. Figure 1 shows the yearly survivals. Daland followed the patients in one hundred cases and found that 26 per cent lived five years.

#### SECONDARY OPERATION ON FIRST VISIT

There were twenty-one who had previous mastectomy, local excision, or x-ray therapy before their first visit to the Tumor Clinic. Local recurrence was present in four, regional metastasis was found in ten and remote metastasis was present in seven. Surgery or irradiation was used in all. Only 4.7 per cent were free of cancer one year after the secondary treatment. Forty-seven per cent were alive one year later; 26 per cent, two years later; and only 6 per cent, three years later.

#### ANALYSIS OF EIGHTY PRIMARY MASTECTOMIES

Primary mastectomy was done in eighty patients as a curative measure. This group made up 77 per cent of all patients seen. Sixty-nine radical mastectomies and eleven simple mastectomies were done. In 40 per cent of these patients, the disease was limited to the breast. Sixty per cent showed axillary involvement. Follow-up was carried out on all of these patients. There were 63 per cent survivals at three years and 44 per cent at five years. Forty-eight per cent were clinically free of cancer at three years and 36 per cent at five years.

TABLE II  
EFFECT OF AXILLARY INVOLVEMENT ON PROGNOSIS IN  
BREAST CANCER

##### Limited to Breast

1 year later: 100% survivals: 90% clinical "cures"  
3 years later: 90% survivals: 87% clinical "cures"  
5 years later: 72% survivals: 60% clinical "cures"

##### Axilla Involved

1 year later: 73% survivals: 48% clinical "cures"  
3 years later: 46% survivals: 23% clinical "cures"  
5 years later: 27% survivals: 22% clinical "cures"

When the disease was limited to the breast, there were 72 per cent survivals and 60 per cent clinical "cures" five years later. When the axillary lymph nodes were

involved, there were 27 per cent survivals and 22 per cent clinical "cures" five years later. The survivals and "cures" in these groups are shown in Table II.

Since 70 per cent of the patients were given postoperative irradiation, it is of interest to note its effect on the end result. For this reason Table III is included to show the end results in patients followed after mastectomy comparing those with and without postoperative x-ray therapy.

#### CANCER OF BREAST IN YOUNG WOMEN

There were twelve patients under thirty-six years of age with cancer of the breast. The average age of this group was thirty-one years. Radical mastectomy was done in all but one.

Seven were not associated with pregnancy. Two of these were limited to the breast and were clinically free of cancer when examined three years later. The axilla was involved in five. None of these were alive three years later. The average length of life was only one year and eight months after operation in this latter group.

There were five associated with pregnancy. Three were pregnant at the time of the first examination and two became pregnant within five months postmastectomy. All had radical mastectomy and postoperative irradiation. All had bone metastasis within a few months. Four died within one year. One lived twenty-two months. The average length of life was one year and three months postoperatively. Figure 4 shows the importance of the extent of the disease in prognosis in young women as it does at any age.

#### PAGET'S DISEASE OF THE BREAST

Paget's disease is quite rare. Only six cases have been seen during these ten years. The patient was older, the average age was fifty-nine and a half years. The average duration of complaints was 3.1 years. If the youngest patient of forty-seven years with only a history of seven months' duration would be excluded, the average age reached sixty-two years with



an average duration of 4.2 years. They complained of an ulcer or eczema of one nipple. The findings, typically described by Cheate, Ewing and others, were chronic red, scaly or granular, superficial ulceration about one nipple. The nipple was usually lost. Only one showed axillary involvement.

she had metastasis to the spine with considerable pain. X-ray therapy was given again.

#### RECURRENCE

In clinical examination of ambulatory patients at the Tumor Clinic, the location of recurrent postoperative malignancy was

TABLE III  
END RESULTS OF EIGHTY PATIENTS TREATED BY PRIMARY MASTECTOMY WITH AND WITHOUT POST-OPERATIVE IRRADIATION

Cancer of Breast	All Mastectomies					Simple Mastectomy					Radical Mastectomy				
Follow-up	Total No.	Living		Cures		Total No.	Living		Cures		Total No.	Living		Cures	
		No.	%	No.	%		No.	%	No.	%		No.	%	No.	%
One year later.....	80	67	84	52	65	11	10	91	6	55	69	59	83	46	67
Limited to breast.....	32	32	100	29	90	7	7	100	6	87	25	25	100	23	92
With x-ray.....	19	19	100	16	84	2	2	100	1	50	17	17	100	15	88
No x-ray.....	13	13	100	13	100	5	5	100	5	100	8	8	100	8	100
Axilla involved.....	48	35	73	23	48	4	3	75	0	0	44	32	73	23	52
With x-ray.....	37	27	73	19	51	1	0	0	0	0	36	27	75	19	53
No x-ray.....	11	8	72	4	36	3	3	100	0	0	8	5	63	4	50
3 years later.....	79	50	63	38	48	10	7	70	5	50	69	43	62	33	48
Limited to breast.....	31	27	87	26	84	6	6	100	5	83	25	21	84	21	84
With x-ray.....	18	16	89	15	83	2	2	100	1	50	16	14	88	14	88
No x-ray.....	13	11	85	11	84	4	4	100	4	100	9	7	78	7	77
Axilla involved.....	48	22	46	11	23	4	1	25	0	0	44	21	48	11	25
With x-ray.....	37	17	46	9	24	1	0	0	0	0	36	17	47	9	25
No x-ray.....	11	5	45	2	18	3	1	33	0	0	8	4	50	2	25
5 years later.....	66	29	44	24	36	7	3	43	3	43	59	26	44	21	36
Limited to breast.....	25	18	72	15	60	5	3	60	3	60	20	15	75	12	60
With x-ray.....	15	12	80	9	60	2	1	50	1	50	13	11	85	8	62
No x-ray.....	10	6	60	6	60	3	2	75	2	75	7	4	57	4	57
Axilla involved.....	41	11	27	9	22	2	0	0	0	0	39	11	28	9	23
With x-ray.....	32	9	28	7	22	0	0	0	0	0	32	9	28	7	22
No x-ray.....	9	2	22	2	22	2	0	0	0	0	7	2	28	2	28

Two patients refused treatment. One was not seen again and one has been followed over two years with no clinical change. Three with mastectomy and negative glands were five-year clinical cures (100 per cent cures). One of these showed cancer of the other breast nine years later. The one patient with axillary involvement was treated by radical mastectomy and postoperative irradiation. Recurrence was present in the axillary stab wound two months later and did not progress there in six years. Four years postoperatively,

noted. The location and frequency of recurrence is pointed out in Table iv.

In the group in which cancer was originally limited to the breast, 13 per cent developed local recurrence, 6 per cent regional and 26 per cent remote metastasis. In those in whom the axilla had been involved originally, 25 per cent subsequently showed local recurrence, 10 per cent regional and 75 per cent remote metastasis. Local recurrence appeared three times as often, and regional metastasis two and one-half times as frequently, after

simple mastectomy than it did after radical mastectomy. (Table v.)

Although 70 per cent of the local recurrences appeared within one year after the

The 16 per cent who showed local recurrence were then treated by surgery or irradiation. Only 12 per cent of these were free of cancer one year later.

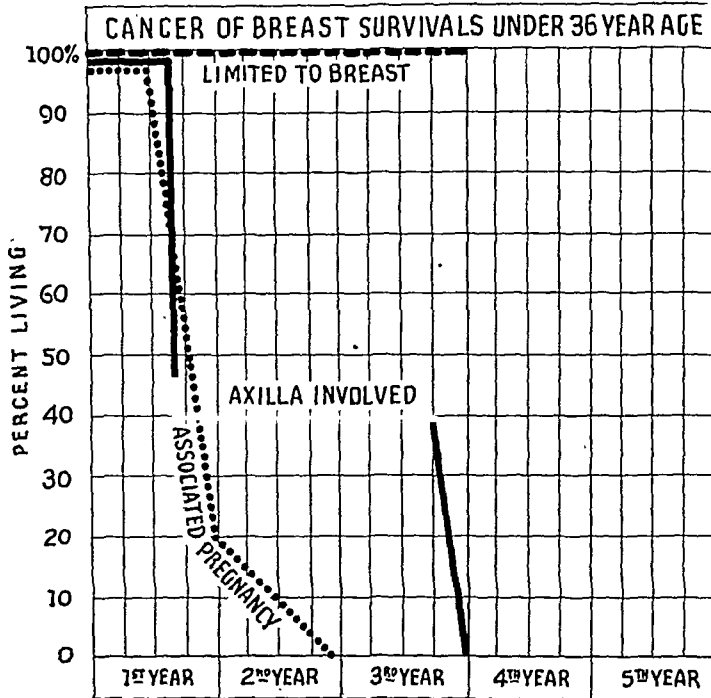


FIG. 2.

primary operation, one-half of the local recurrences seen in the group that had been limited to the breast appeared after

TABLE IV  
POSTOPERATIVE RECURRENCE

Location	Fre- quency, Per Cent	Within One Year, Per Cent
Local.....	16	70
Regional.....	9	80
Lung or liver (each).....	9	57
Bone.....	28	62
Other breast.....	5	25
Reoccurrence—2 cases in other breast		

five years. There was only 14 per cent local recurrence when a simple mastectomy was done and the axilla negative clinically, whereas there was a 71 per cent recurrence if the axilla was involved clinically.

TABLE V  
COMPARING FREQUENCY OF RECURRENCE AFTER SIMPLE  
AND RADICAL MASTECTOMY

	Simple, Per Cent	Radical, Per Cent
Local recurrence.....	43	14
Regional metastasis.....	15	6
Remote metastasis.....	30	36

COMMENT

The end results in this series show definitely that the extent of the disease was very important in prognosis. When the cancer was limited to the breast, the outlook was much brighter than when the axillary nodes were involved. There were 45 per cent more five-year survivals in the former group. This agrees with the findings of others as seen in Table VI. Difference in end results probably depends

on proper selection of cases. Haagenson and Stout<sup>11</sup> advise increasing the criteria of operability to improve the end results of radical mastectomy for carcinoma of the breast.

TABLE VI  
COMPARATIVE FIVE-YEAR END RESULTS IN BREAST  
CANCER

Hospital or Author	Limited to Breast		Axilla Involved		Local Recurrence, Per Cent
	Survivals, Per Cent	Cures, Per Cent	Survivals, Per Cent	Cures, Per Cent	
Milwaukee County . . . . .	72	60	27	22	16
Mayo Clinic (Harrington) . . . . .	73.6		28.5		8
Presbyterian, N.Y. (Haagenson and Stout) . . . . .	70.9	61.2	52.5	21	22.8
Huntington Mem. (Simmons) . . . . .		74		25	9.5
Wisconsin General (Pohle) . . . . . (Hidde et al.) . . . . .		53 18 surv. (all)		28	
Geschickter . . . . .	75		28		
Rodman . . . . .		63.5		23.5	2.2
Graves . . . . .	60		24		
Pfahler . . . . .	73		52		
Memorial, N.Y. (Adair) . . . . .	76.8		41.8		

The best results were obtained in those malignancies that were recognized and treated early. The age did not seem to be a factor. The youngest, aged twenty-seven years, with the cancer limited to the breast, was clinically free of cancer three years later. The oldest, age eighty-three years, died of intercurrent disease three years later.

In 82 per cent, the first complaint was a painless lump in the breast. This was considered a pathognomonic symptom of cancer. More than one-third of these tumors in our series were over two and one-half inches in diameter when first seen. In the past few years the average size of the tumor was smaller because the patients were going to the doctor sooner.

The delay between the onset of the first complaint and the first consultation with a doctor was less than four months in 55 per cent of those with cancer limited to the breast and in 50 per cent of those with the axilla involved. There was no delay in 20 per cent, one to four months' delay in 35 per cent, five to twelve months' delay in 19 per cent and over one year delay in 26 per cent. In the inoperable group, the delay was always over six months and averaged 1.9 years. Delay in therapy of over one month after the first visit to the doctor occurred in 17 per cent. This was most likely due to wrong diagnosis.

This delay is being shortened by education. The Annual Cancer Campaigns, stressing "see your doctor at once if you have a tumor," have definitely brought the patients in earlier. The grave importance of the early diagnosis of breast cancer is being stressed to medical students and to the resident staff to make them "cancer conscious." They look for cancer.

There has been a 7 per cent increase in five-year survivals when limited to the breast and a 12 per cent increase in survivals when the axilla was involved in comparing the end results found in 1942<sup>6</sup> with these of 1944.

The end results in Paget's disease indicated an almost benign course with mastectomy unless the axilla was involved. Cancer of the breast associated with pregnancy was rapidly fatal.

This study did not show any appreciable difference whether postoperative irradiation was given or not. This agrees with the opinion of Simmon, Taylor, Robillard, Geschickter, and Haagenson and Stout. Adair, Graves and Pfahler believe that x-ray therapy definitely improves the end results. Our policy in the past few years has been to give postoperative irradiation when the disease was not limited to the breast.

Haagenson and Stout believe that biopsy, at operation or six days or less before, does not increase the local recurrence nor

decrease the five-year clinical cures. Greenough expresses a similar opinion. Cutler believes that dissemination is greater with

they showed recurrence or metastasis at about four years when a five-year clinical cure had been anticipated.

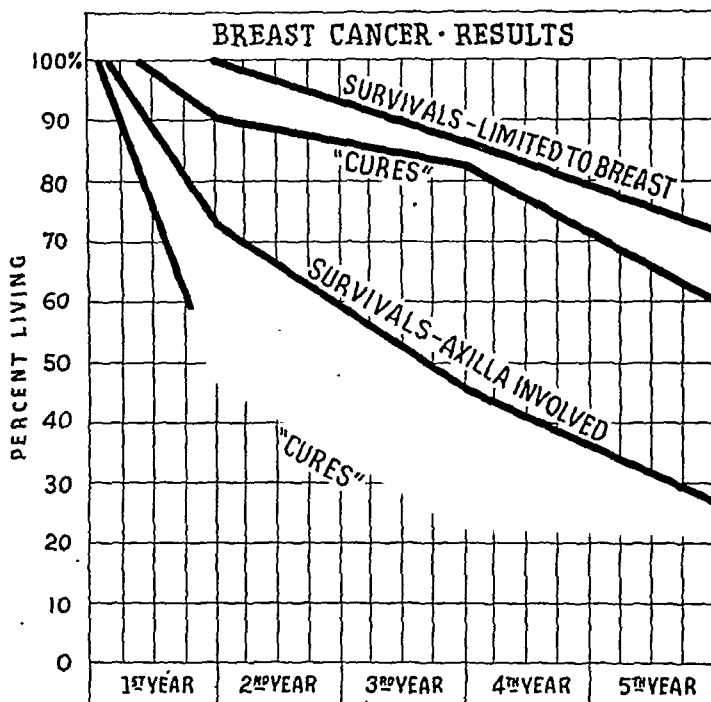


FIG. 3.

preliminary biopsy. Our records were not complete enough to permit an opinion. Geschickter's advice that small tumors should be excised with a margin of normal tissue and without squeezing seems reasonable.

Postoperative local recurrence was a bad omen and offered a poor prognosis except in occasional instances. The multiple, small, lenticular intradermal lesions seemed to be accompanied by a miliary spread. The rare erysipeloid type of recurrence was followed by a rapidly fatal end.

The patients with postoperative recurrence or metastasis comprised the frequent visitors at the Tumor Clinic. They are shown graphically in Figure 3 as the groups between "cures" and survivals. They were a psychological problem to themselves, to the other patients and to the medical students. The patients required confidence and encouragement as well as alleviation of pain. They were a discouraging group to care for particularly when

#### CONCLUSION

1. The end results of 122 patients with cancer of the breast are reported.
2. Eighty patients had a primary mastectomy. Forty-eight per cent were living with no evidence of disease three years after operation. Thirty-six per cent were five-year clinical cures.
3. When confined to the breast, there were 60 per cent five-year clinical cures. With involvement of the axillary nodes, there were 22 per cent five-year clinical cures.
4. There has been improvement in the end results in the past few years by earlier diagnosis.

#### REFERENCES

1. ADAIR, F. E. The role of surgery and irradiation in cancer of the breast. *J. A. M. A.*, 121: 553, 1943.
2. CHEATLE, G. L. and CUTLER, MAX. Tumours of the Breast. Philadelphia, 1931. J. B. Lippincott Co.
3. CUTLER, MAX and BUSCHKE, FRANZ. Cancer—Its Diagnosis and Treatment. P. 493. Philadelphia, 1938. W. B. Saunders Co.

4. DALAND, E. M. Untreated cancer of the breast. *Surg., Gynec. & Obst.*, 44: 264, 1927.
5. EWING, JAMES. *Neoplastic Diseases*. P. 871. Philadelphia, 1934. W. B. Saunders Co.
6. GARLAND, J. G. Common diseases of the breast. *Marquette Med. Rev.*, 8: 139, 1943.
7. GESCHICKTER, C. F. *Diseases of the Breast*. Philadelphia, 1943. J. B. Lippincott Co.
8. GRAVES, S. C. Carcinoma of the female breast. *New England J. Med.*, 225: 57, 1941.
9. GREENOUGH, R. B. Early diagnosis of breast cancer. *Ann. Surg.*, 102: 233, 1935.
10. HAAGENSEN, C. O. and STOUT, A. P. Carcinoma of the breast. Results of treatment. *Ann. Surg.*, 116: 801, 1942.
11. Idem. Carcinoma of the breast. Criteria of operability. *Ann. Surg.*, 118: 859, and 118: 1032, 1943.
12. HARRINGTON, S. W. Carcinoma of the breast with results of radical mastectomy. *Surg. Clin. North America*, 21: 1063, 1941.
13. Idem. Results of radical mastectomy in 5026 cases of carcinoma of the breast. *Pennsylvania M. J.*, 43: 413, 1940.
14. HIDDE, F. G., MALEC, J. P. and GALE, J. W. Carcinoma of the breast. *Am. J. Surg.*, 49: 427, 1940.
15. PFAHLER, G. E. and VASTINE, J. H. Carcinoma of the breast. *J. A. M. A.*, 110: 543, 1938.
16. POHLE, E. A. Roentgen therapy in cancer of the breast. *Radiology*, 38: 516, 1942.
17. RODMAN, J. S. Skin removal in radical breast amputation. *Ann. Surg.*, 118: 694, 1943.
18. ROBILLARD, G. L. et al. Management of tumors of the breast. *Am. J. Surg.*, 60: 235, 1943.
19. SIMMONS, C. C. Cancer of the breast. *New England J. Med.*, 226: 173, 1942.
20. TAYLOR, G. W. Cancer of the breast. *Internat. Abstr. Surg.*, 55: 1, 1932.



*Pain in the chest* may be due to metastasis in the pleura from carcinoma of the uterus, breast, or other organs; pleural effusion or hemothorax may be due to metastasis in the pleura or mediastinum.

From "Metastases Medical and Surgical" by Malford W. Thewlis (Charlotte Medical Press).

# DERMOPLASTY OF WAR WOUNDS OF THE LOWER LEG

MAJOR JOHN F. PICK

MEDICAL CORPS, ARMY OF THE UNITED STATES

THE severity of war wounds is a test of surgical ingenuity and adequacy of method. The exigencies of war perforce create problems which challenge normal surgical procedures. The imperatives of wound management under battlefield conditions, may so influence the course of healing as to call for changes in method of subsequent treatment. The original care of any wound permeates not only its course and response to routine treatment, but often dictates newer or more complex surgical procedures in its ablation. War wounds are different from civilian wounds only in degree and origin. The surgical principles underlying the management of both are the same.

A directive from the Office of The Surgeon General states: . . . "It is strictly forbidden that any compound fracture or extensive wound of the extremities be treated with closure of the wound."\*

The above imperative policy has proven to be a good one. It has prevented many complications, such as gas gangrene, and undoubtedly has saved many lives. This results in the most good for the greatest number.

The same policy, on the other hand, has unavoidably created certain consequent surgical problems which must be met, before any ultimate reconstructive surgery can be contemplated or functional rehabilitation realized. These unavoidable surgical consequences are: Unstable extensive healed scars (Fig. 3), indolent ulcers (Fig. 2), gaping compound wounds with visible bone (Fig. 1), or combinations of these. The complexities of such a wound call forth a kind of foreign body reaction rather than normal tissue regeneration. The body is on the defensive

against too severe and complex an injury. Nature by herself is no longer able to conquer the task. Surgical revision to re-establish anatomic and physiologic integrity of the injured part becomes a prior necessity. Only then does the injured member lend itself to ultimate rehabilitation.

There is at present no unanimity of opinion as to the best management of such wounds. And yet, from the standpoint of avoiding still further distortion of contiguous tissues, it is imperative that the indolent wound be ablated as soon as possible. For to sacrifice further the integrity of tissues in or adjacent to the defect, means augmenting of the difficulties of ultimate rehabilitation. This problem will increase in magnitude as the war goes on because of the high rate of these injuries, and may remain one of the great post-war surgical problems which we will have to face.

The treatment of these patients in accordance with ordinary surgical practice is inadequate. The usual management consists of a period of weeks or months of wound hygiene and dressings, with collateral tissue atrophy of the entire extremity. The next usual step consists of excision of the large scar or the ulcer, as the case may be, and the application of some type of free skin graft, too commonly a split graft. This accomplishes one thing. It makes a closed wound out of an open wound. The principle is a good one, but the results are insufficient, because such covering is anatomically inferior and therefore physiologically inadequate. Nature will not permit physiologic restitution with only partial anatomic replacement, without making some attempt at histologic compensation. Such grafts, when re-entered, are difficult, if not impossible,

\* B.G.O. Circular Letter No. 189, November 17, 1943.



FIG. 1. Case v. Compound fracture of left lower leg, nineteen months after injury. Portion of tibia protruding is dead. It was drilled at former hospital soon after injury with above results. No deep infection, but wound refuses to heal. Amount of excision at time of dermoplasty shown in Figures 6, 9 and 10.

FIG. 2. Case III. Indolent ulcer of right tibia, six months after compound fracture of lower leg caused by high explosive shrapnel. Orthopedic problem illustrated in Figure 25. Amount of tissue excised included all of fibrotic mass about ulcer. Extent thereof can be seen from length of healed "bridge" in Figure 26.

FIG. 3. Extent of healed ulcer can be seen, with

to re-suture and conserve after extensive reconstructive surgery. To this I should like to add that when closing a wound,

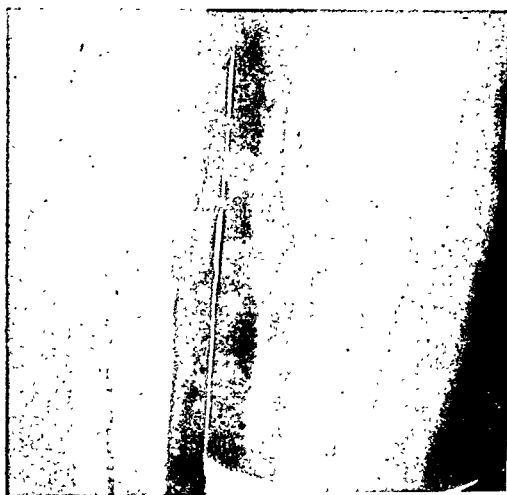


FIG. 4. X-ray of left lower leg taken ten months after fracture of both tibia and fibula, due to high explosive shrapnel. Orthopedic work delayed because wound did not heal even after ten months, only as shown in Figure 3, with bone still protruding; onlay graft done six weeks after dermoplasty.

whether by apposition of its own edges or through the medium of a graft, it should as nearly as is possible be obliterated by tissues necessary in that locality and *without* force. To use distorted or forced tissues is to defeat the very principles of good repair. *In that connection, a suture should rarely be put to any other use than to act as a splint for a unit of tissue, which is in place but cannot or may not maintain its position.*

It is easy to free graft a defect, particularly with the advent of the modern dermatomes. But it is a challenge to so cover and bring to health a tissue lack or deformity that the affected part will give promise of ultimate functional excellence. Any choice of procedure aiming at less than that is not consistent with the demands of modern surgery, unless it be only done to save life. As a matter of fact, much of the inadequacy of our gen-

black dry necrosed portion of proximal tibial fragment protruding through skin. The badly fractured un-united tibia is represented by the undulations of the scar.

erally employed methods of revision of severe tissue deformities is due to the injudicious use of free skin grafts, particu-

eight to ten months, by the more rapid and physiological conversion of an open into a closed case and the better elimina-



FIG. 5. Six of the twelve hypodermic needles usually employed by author are shown in place for infiltration of 1 per cent novocain. The almost healed ulcer over tibio-fibular fracture is outlined by dots. The incision for the future double pedicle "bridge" is indicated by the concave black line on lateral side of lower leg.



FIG. 6. Case v. Compound fracture of left lower leg. Amount of excision indicated by outline. Film pattern held by hemostat, is being turned 180 degrees to cover lateral side of leg from which "bridge" flap will be shifted into defect after excision. Method of excision shown in Figure 8, and tissue excised *en masse* in Figure 10.

larly of the less than full thickness variety, cruel technic and careless suturing.

The method herein presented, in lieu of the above practice, is a series of procedures based upon selected and proven principles of plastic surgery. The premise for such a method was known to Celsus; its logic is borne out by results. The method has been employed by the author with good results in a series of fifty cases of extensive war wounds of the lower extremities, at an Army General Hospital over a period of ten months. It is the hope that in emphasizing certain principles, applying them to accepted procedures, and formulating the latter into method, it may be of help in the management of the pressing problem of revision of certain deformities resulting from extensive war wounds. If so, then the difficulties of subsequent reconstructive surgery and physical rehabilitation, *as well as the time element involved*, will have been reduced to a minimum.

It is the opinion of those of us involved in the use of this method, that the over-all time necessary in the hospitalization of such patients has been reduced by from

tion of extensive, unstable scars over internally deranged tissues needing reconstructive surgery.

#### METHOD

*Introductory.* (Figs. 3 and 4.) I shall confine the description of the method to its application in the management of a compound fracture of the left lower leg, treated according to the open method, terminating in non-union, ulceration and unstable healing with deformity.

*Preoperative Care.* Given a leg with an open ulcer, a culture is taken of its depths. It is thoroughly scrubbed for one-half hour or more and irrigated with saline. The wound is then packed with gauze, moistened with 1 per cent chlorazinc solution or one-half strength Dakin's solution. Into the gauze pack is placed a rubber catheter and the leg bandaged over sterile dressings. Through the catheter, the humidity of the pack is maintained by repeated instillations of the chlorazinc or of Dakin's solution for a period of three days. At the end of that time, the dressings and the pack



are removed and the wound irrigated with saline. It is gently dried, and a culture is taken.

The wound is again repacked, except that normal saline is substituted for Dakin's solution. After three days, the dressings are opened and another culture is taken of the depths of the wound. Usually the wound is bacteriologically clean, or much improved. Should the bacterial flora be augmented, the Dakin's solution is repeated for three more days. If indicated, one of the sulfa compounds is given orally.

When the wound has shown definite bacteriologic improvement and is able to maintain it during any three days of the closed saline treatment, boric acid solution is substituted for the saline for an additional three days. The case is then ready for surgical planning.

Technically, it can be now attacked in the same manner as a similar extremity without ulceration, but with an unstable, extensive scar over the location of the injury. (Fig. 3.) The management of the latter follows:

The extremity, forty-eight and again twenty-four hours before the operation, is shaved and thoroughly scrubbed with soap and water. It is then dried with alcohol and painted with tincture of mercuric iodine. Under sterile precautions, it is wrapped in dressings.

*Preoperative Preparation.* The sterile dressings of the previous day are removed on the operating table. The entire leg is again rescrubbed with soap and water. It is then dried with ether and painted with tincture of mercuric iodine. The stage is draped for surgery.

#### SURGICAL PROCESS

*Step No. 1 (Fig. 6).* A washed, transparent x-ray film is laid on the defect, be it ulcer or deforming unstable scar, and an exact copy is cut of the outlines of the defect. The pattern is then turned over to one or the other side of the defect, through an arc of 180 degrees. The choice

of the side of the extremity depends upon where the better quality of tissue is available. The film pattern is held securely against the leg and its outer edge indicated on the skin by a line made with aniline dye. (Fig. 5.)

The skin around the ulcerated area is now penetrated via previously raised wheals, by long hypodermic needles. This usually requires a dozen such needles. After these are inserted to the extent of their full length, 1 per cent novocaine is gradually injected as a needle is being withdrawn. This is repeated until all the needles have been withdrawn and the entire surgical stage has been infiltrated. The exact area, or ulcer, to be excised is then outlined as shown in Figure 5 by dots of aniline dye.

*Step No. 2 (Fig. 7.)* The defect is now very carefully and completely excised. In the case of an extensive healed but unstable scar, as shown in Figure 3, open excision as illustrated in Figure 7 is practiced, whereas in conditions such as shown in Figure 1, the open wound is first covered by gauze, which is then sewn to the defect as illustrated in Figure 8. This is done to avoid dissemination of ulcer debris into the surgical stage. The wound, including any bone protruding into it, is excised *en masse*, leaving a defect as shown in Figure 9. One is now ready for further detailed excision of the undesirable tissue. The amount of primary excised tissue in Figure 9 is shown in Figure 10. Every bit of pathological tissue whose presence would not leave a completely clean bed for grafting must be removed. The fact that the excision involves so much tissue that only bare bone or tendon remains as a bed for grafting is of no consequence. As in the case herein shown and illustrated, a large part of the tibia, bare of all other tissue, protruded into the excision. Much of this bone was removed in order to avoid leaving any sharp, bony prominences. In other cases, all dead and sometimes bacteriologically unsterile bone was also removed. It must be obvious by this time that such

a procedure leaves a very extensive and deep defect which cannot be satisfactorily covered by even full thickness skin.

by a thin, transparent, membrane-like sheath of fibrous tissue. When this has been reached and identified, the adipose

FIG. 7.

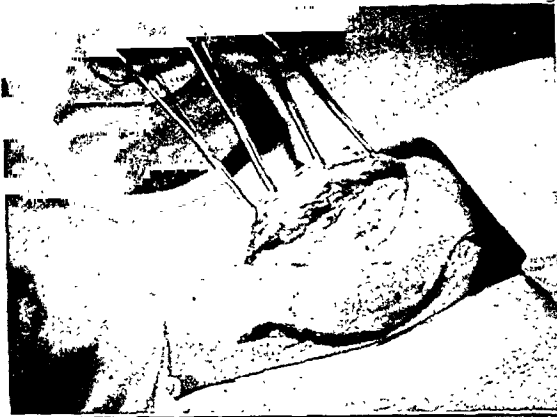


FIG. 8.

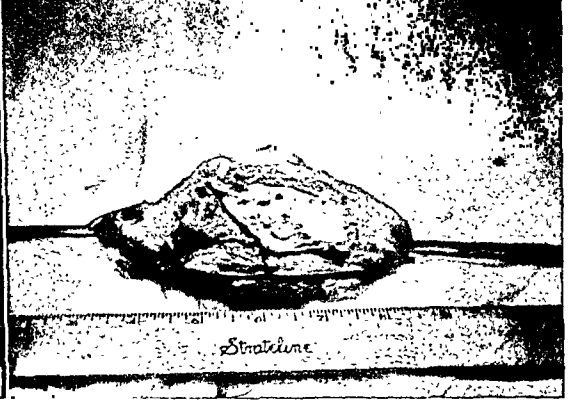


FIG. 9.

FIG. 10.

FIG. 7. The ulcer area, including an attached tibial bone fragment at its lower angle, is shown supported by Ellis clamps and still held by its medial boundary. The lateral incision for creation of the double pedicle "bridge" has been made. The careful undermining of the latter is ready to proceed. In the angles of the incision, its depth can be made out.

FIG. 8. Showing method used to avoid dissemination of ulcer débris when excising open ulcer. Sutures are placed into edge of outlined area to be excised. The ends are left long enough to be tied over gauze. Excision can then begin without fingers and instruments getting into ulcer.

FIG. 9. Same extremity as in Figures 7 and 8. Excision completed showing extensive defects of tibia as well as amount of soft tissue which had to be sacrificed. Free grafting of such defects is out of the question.

FIG. 10. Showing amount of tissue excised in Figure 9 including bone; length 6 inches. Underside of tissue shown to illustrate position and size of excised bone as well as type of excision.

The aniline line previously drawn about the outer periphery of the film pattern is now converted into an incision. This incision should only extend in depth about half-way through the subcutaneous fat, as shown in Figure 7. *This is an important and necessary detail in the operation.* By very careful incision into the subcutaneous fat, a level is reached about half-way through its thickness, at which point it is quite definitely separated into two layers

tissue is very carefully separated along this line in the direction of the defect. The obvious separation of the subcutaneous fat into two layers permits this part of the operation to be done almost bloodlessly through careful, sharp dissection. The separation is extended throughout the area of the outlined flap and well into its upper and lower extremities. This having been completed, there is created a double pedicle flap consisting of the entire thickness of

skin plus a good subcutaneous layer of non-traumatized fatty tissue; enclosed by its own membrane-like, transparent sheath.

which considerable tibial bone has been removed, even this thick bridge of tissue sometimes acts as only a roof for the defect

FIG. 11.



FIG. 12.

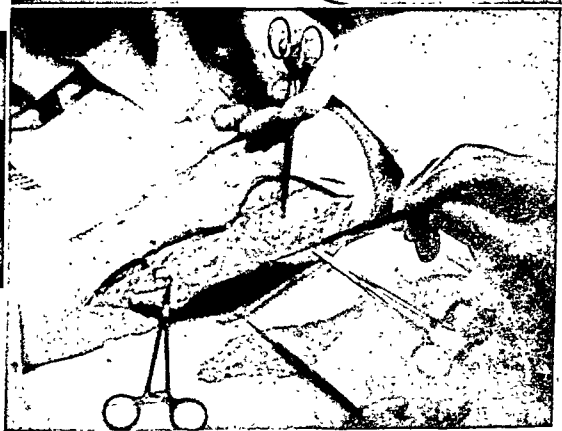


FIG. 13.

FIG. 14.

FIG. 11. The "bridge" flap has been mobilized, its edges supported by hooks. Note its thickness, due to fat pad under skin. It is now held over tibia. Note fat remaining on calf muscles. The resulting fresh defect is obvious. Note its somewhat larger extent than the original ulcer. The still attached ulcer tissue is seen held by Ellis clamps for contrast.

FIG. 12. Showing method of utilization of unexcised deep layer of subcutaneous fat, in filling bony defects remaining after removal of dead or at times still infected bone. The large long pedicled fat flap was designed to reach into deep distal bony defect just above ankle and indicated by hemostat. The smaller flap was designed to fall into dark depression in tibia midway between pedicle of flap and hemostat. Only a double pedicle "bridge" flap which has its own circulation could survive over such a bed. Free grafts are absolutely out of the question. Results in this case were even better than expected.

FIG. 13. The ulcer tissue has been completely detached. The inner side of flap has been approximated to what was the medial aspect of the ulcer. The size of the newly created raw surface can be compared with the six-inch hemostat.

FIG. 14. The residual fatty layer in the new defect has been dissected from the underlying muscles. It is still attached on its lateral aspect and supported by a hook. The outer rim of the defect can be seen pulled down and out under the fat flap to show its undermining. Along the near side of the defect under the left-hand held hook, is the shrunk, excised ulcer tissue.

(Fig. 11.) The flap has its own arterial and venous circulation and most of its innervation conserved. Being completely undermined and freed under its extremities, it can now be moved in the direction of the defect so as to cover it. Yet in a case in

whose depth is greater than the thickness of the flap. It is at such times that the import of the meticulous splitting of the subcutaneous fat becomes evident. It is now that the deep one-half of the subcutaneous fat serves its separate purpose.

This fat still remaining over the leg muscles, can now be fashioned into one or several separate single or double pedicle

in these reconstructions, with all its attached fat underneath, it is frequently necessary to delay the flap. Such delay



FIG. 15. The residual fat is now shown excised except for its most distal attachment supported by a hook. The upper angle of the wound is shown undermined and loose.



FIG. 16. The fat formerly overlying calf muscle has been totally excised. Both upper and lower angles have been undermined, as well as the lateral side of the defect. This has resulted in a shortening of the leg circumference, so that the angles of the wound have been approximated to such a degree as to reduce the defect by 50 per cent, thus making it smaller than the original ulcer. The size of it can be in all fairness compared with other photographs because camera and extremity were maintained in original position throughout the operation.

flaps, each one having its artery of supply, and so employed to fill in cavities resulting from the removal of dead bone. (Fig. 12.) To have taken up all the subcutaneous fat with the skin originally, would have prevented the necessary separate placement of pedicle fat flaps in the bone defects. Pressure alone over the bridge of skin containing full thickness fat would not accomplish the same end. The amount of pressure necessary to obliterate the dead space underneath, which would otherwise remain, is fundamentally contraindicated. Such pressure would result in necrosis of the most vulnerable part of the tissue bridge, its middle one-third.

Further question may be raised as to the logic or feasibility of dissecting out only one-half of the thickness of the subcutaneous fat. It may, therefore, not be remiss to indicate that since the deepest layers of fat contain the large and important blood vessels thereto, and since the soft fat is always at the mercy of the relatively more rigid skin, it becomes obvious that to force the deep layer of fat into any position the skin bridge may have to assume, is to invite angulation of the deep vessels and consequent necrosis of the fat. Further than that, experience has shown that to move as large a flap as is usually necessary

not only increases the circulation to the flap, but augments the integrity of its vessel so that the latter can stand more twisting and stretching without collapsing or obliterating. That again uses up time, which can be saved by the above indicated procedure. Finally, it is not cosmetically justifiable to have more than the normal or natural amount of skin and fat over the tibia.

*Step No. 3. (Fig. 13.)* The double pedicle flap having been properly mobilized can now be lifted and moved over the defect as shown in Figure 11, thus forming a bridge. (In the same photograph, over the upper border of the bridge, is still seen the not completely detached sclerosed and ulcerating tissue for contrast.) All hemostasis having been attended to in the ulcer-excised area, the flap is spread out over the tibial defect and the far edge of it is carefully sutured to the normal skin, as shown in Figure 13.

The shifting of the flap, as can be seen, results in a new, surgically unavoidable defect on the lateral side of the leg. This is the new but easier problem. It can be done in several ways. On the principle that primary closure is always preferable and more ideal surgery, it is well to reduce the size of the defect, if possible, and coincidentally avoid the use of large free grafts. *This problem the author solves by reducing the circumference of the leg.*

*Step No. 4 (See Photograph #7) (Fig. 14.)* To reduce the circumference of the leg, the deep layer of adipose tissue remaining after the creation of the double pedicle flap, is now carefully stripped from the underlying fascia of the muscle. If the dissection is done carefully, a very fine film of fat still remains on the fascia. It is well to leave this behind. It avoids traumatizing or buttonholing of the fascia and, more than that, it seems a kinder bed for the small free graft which is to follow.

The removal of the deep layers of fat from the surgically created defect is usually sufficient so as to shorten the circumference of the leg, permitting at least the angles of the defect to be approximated, as shown in Figure 16. This usually results in a 30 to 60 per cent reduction of the area, depending upon the original thickness of the fatty layer and the elasticity of the skin.

The geometric relationship between the size of the original defect, the secondary defect resulting from the shifting of the "bridge" flap and the small size of the free graft necessary to cover the residual defect, following shortening of the leg circumference in one case, is shown in Figure 17.

The relation of size of original wound to final free graft in another case is shown in Figure 18.

Should the above excision of fat prove inadequate for a material reduction of the area, further removal of adipose tissue can be resorted to from the posterior aspect of the leg as illustrated in Figure 15.

Decided care must be exercised in preserving the nerves and vessels as they are encountered.

In two of our cases, the entire lower leg was stripped of fat, making it possible to close the surgical defect completely without any free grafting. The procedure is rather time-consuming if done with care, which must be an objection to it by the occasional operator. It is only recommended in very extensive loss of skin, where too much time would be consumed in transporting it from other regions, or where such an amount of skin is not readily available.

*Step No. 5 (Fig. 16.)* The surgical defect having been materially reduced by approximation of its extremities, leaves only the problem of free grafting a residual area which, because it is a clean, surgically created wound, is a far better bed for any kind of free graft than the original ulcer-excised defect could ever be. The type of skin graft to be used may be a matter of choice with the surgeon. Personally, I am very partial to full thickness skin. A word of caution. In the reduction of the surgical defect, by direct approximation of the skin edges at its extremities, it should never be carried to the point where the suture tension is such as to produce distortion of the edges or areas of tissue pallor. The sutures will cut through and nothing will have been gained; much will have been lost by the cruel effort.

A pattern is now made of the small residual defect and laid over the skin of the thigh of the same leg. The periphery of the pattern is outlined on the skin with aniline dye. The skin included within this outline is then mobilized through its entire extent as a free graft. The use of full thickness graft seems to me especially important where larger areas need to be covered, because it gives not only better cosmetic but eventually better functional results. Finally, because the aforementioned method leaves a physiologically ideal bed for grafting, one can resort to full thickness skin grafting with much more abandon.

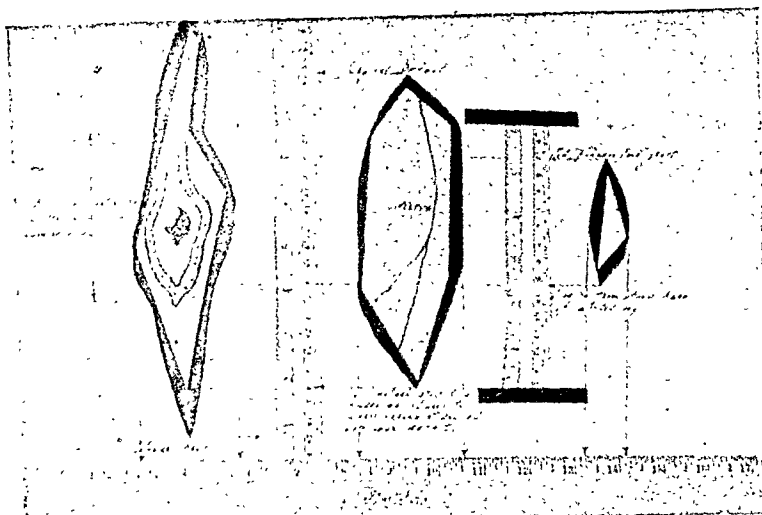


FIG. 17.

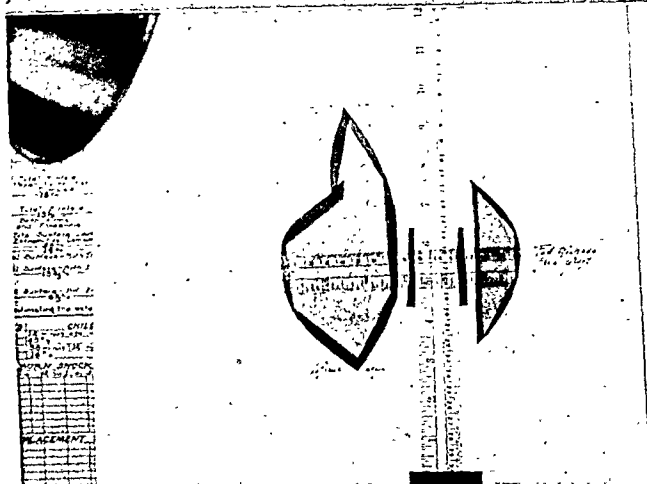


FIG. 18.

FIG. 17. Showing x-ray film patterns illustrating geometric relation between size of defect depicted in Figure 3; size of surgical defect remaining after making of double pedicle "bridge" and size of full thickness free graft necessary to cover surgical defect after latter was reduced by shortening of leg circumference. The overall length of original defect is  $9\frac{1}{2}$  inches. The area between heavy black periphery and dotted double line was heavy scar. The area within dotted double line is the major bone defect of tibia. The central irregular black area represents size and shape of ulceration still present at time of dermoplasty, ten months after original injury. This patient could have had a dermoplasty at least six months sooner, instead of waiting for filling in of wound and fibrosis and then planning on a split graft repair, the common practice. Results of dermoplasty are shown in Figure 24.

FIG. 18. Showing geometric relation of defect in Figure 9 to size of full thickness free skin graft necessary to cover reduced surgical defect remaining after shortening of leg circumference. Had the original ulcer excised defect, shown at left, been free grafted (which was physiologically contraindicated according to author), obviously much more skin would have been necessary and a less desirable bed had to be accepted.

FIG. 19.



FIG. 20.



FIG. 21.

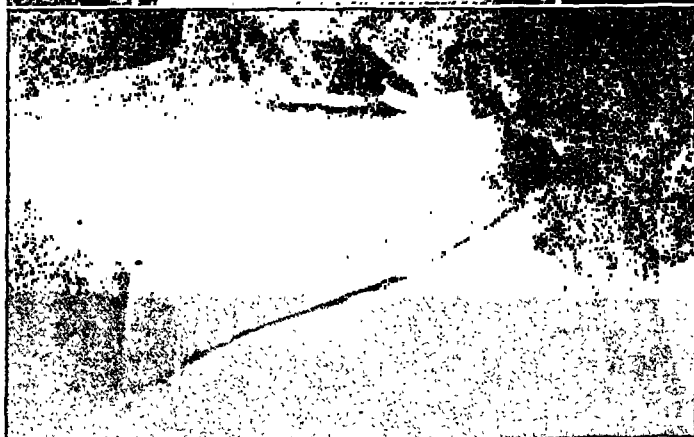


FIG. 19. The operation is shown completed. Note how much shorter the free graft is than the straight suture line, which is all that is left of the original tibial ulcer. It is obvious that to free graft it, would have taken much more skin than was necessary by author's method in creating a new and more ideal bed for any kind of graft. Notice thick and healthy appearance of "bridge" flap over tibia.

FIG. 20. Proximal surgical dressings. Observe circumferential sutures, mentioned in text as arising in gauze strip glued to back of leg. They maintain constant controlled pressure on grafts. Leg is ready for final dressing.

FIG. 21. Dressing completed with roller gauze or elastic bandage, if available. The leg is now ready for light plaster of paris splint. Notice abdominal pad protruding over ankle.

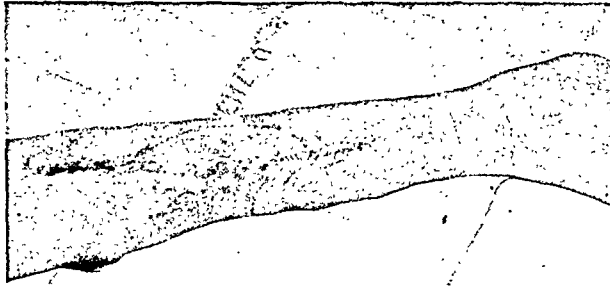


FIG. 22.



FIG. 23.

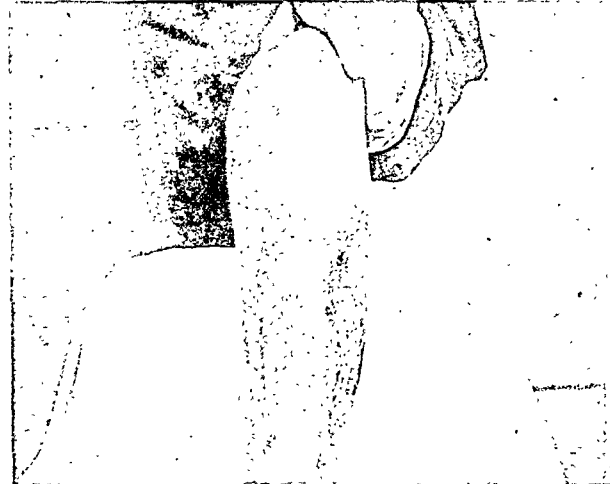


FIG. 24.

FIG. 22. Shows a double pedicle "bridge" flap, the victim of the vicious constriction of an elastic bandage. Its middle one-third is gangrenous, though not completely lost as developments showed. After dermis sloughed, a split graft placed over the remaining underlying tissues reconstituted the bridging of the original defect. The full thickness free graft as shown remained unaffected by the constriction of the elastic bandage. The timely rescue of the subcutaneous tissue under the "bridge" flap avoided re-exposure of the bone and return to the original condition in which the extremity was received.

FIG. 23. Twelve days postoperatively. The "bridge" over tibia is solid, healthy looking and already "glued" to the bone. The medial suture line, particularly the lower half of it, is hardly visible. The full thickness free graft on outer side of leg is well, of good color, and solidly adherent to the underlying tissues.

FIG. 24. Twenty days postoperatively. The "bridge" over tibia is completely healed, soft, well attached to bone



The mobilized full thickness graft is now sutured into place. It is to be noted that when suturing the periphery of the free graft to the "bridge" flap, it is necessary that every occasional suture pick up the fascia overlying the muscles. As a matter of fact, it is advisable to do this with the entire circumference of the free graft. One thereby splints the suture lines, insures proper tension and guards against any possible postoperative dislocation of the graft. (Fig. 19.)

One or two stab wounds are then made in the most dependent part of the free graft. It is neither necessary nor advisable to make a sieve of a free graft by indiscriminate buttonholing. That may result in pockmarking. Two well calculated and appropriately placed small punctures are sufficient. The entire leg is now ready for dressing.

*Step No. 6 (Fig. 20.)* In dressing these patients, it has been the author's practice to take a three-inch wide strip of gauze the length of the lower leg and glue this to the back of it, either with collodion or some type of skin adhesive. After doubling the edges of the gauze inward, about a quarter of an inch, any number of sutures can be placed through the edges and left so that they can later be tied over the dressing as shown in Figure 20. Whatever the dressing, the "bridge" flap over the tibia must enjoy secure apposition to the latter, whereas the free graft must be totally splinted in order to obtain good results. This has been consistently accomplished by first covering the entire operative stage with 3 per cent scarlet red ointment gauze and then placing over this a sheet of sterile cotton one inch in thickness

and *moistened with saline*. The cotton is then tightly pressed against the leg so that all excess saline is squeezed out of it. Over this is placed another two-inch thick layer of sterile cotton, *which must be dry*. That, then, is covered by a large, soft, dry abdominal pad and the entire combination is tied in place by the sutures formerly inserted into the gauze strip glued to the back of the leg. The result is shown in Figure 20. The entire lower leg is then rolled in gauze bandage as shown in Figure 21. Following this, a light plaster cast is applied to the lower leg and the operation is complete.

A word of caution. When the gauze bandage is applied, not too much pressure must be applied over the middle of the "bridge" flap, for that is its most vulnerable point. It is not impossible to shut off its circulation. Elastic bandage is not recommended, for that reason. We have used it in three cases with bad results in one (Fig. 22) and incipient trouble in the other two, discovered in time and circumvented. The reason is that as the saline moistened cotton dries over the "bridge" and postoperative edema sets in, a certain slow automatic pressure reduction results over the entire field with the use of gauze bandage, due to shrinkage of the cotton. Whereas, by using elastic bandage, while the cotton dries and settles against the grafts, the bandage exerts more and more constricting pressure against a swelling "bridge," so that the circulation to a temporarily vulnerable flap is interfered with. This is made only worse by any unevenness of the underlying bone. Spot necroses will result in the flap over

---

beneath it, warm and of the same color as normal skin. A slight flatness can be made out where tibial non-union exists in center of flap. The medial suture line is hardly visible. The free full thickness graft on the lateral side of leg, with the exception of a few superficial points of epithelial discoloration, is well healed and all ready of good color. At extreme upper angle of the free graft is a small epithelial diastasis due to removal of a thin scab. Patient states his "foot feels warmer and better than it has since the injury."

isolated bony prominences from the uncompromising elastic tension of the bandage.

It is much easier to reinforce a loosening

instructed during this time to indulge in limited, controlled, active movements of the leg. The results of this procedure are



FIG. 25. Case III. X-rays of right tibia to show amount of bone damage and orthopedic problem involved. Taken six months after injury. Same case as Figure 2.

gauze bandage than to remove and readjust an elastic bandage.

#### POSTOPERATIVE TREATMENT

The patient, after being placed in bed, had his leg elevated on a pillow and the dressing, including the cast, is left undisturbed from twelve to fourteen days. At the end of that time, the cast and all the dressings are removed and the leg is inspected. Usually it will be found that the full thickness graft is in fine shape, and always it will be found that the "bridge" graft over the tibia is in excellent condition. In fact, it has been the author's experience that the thick flap over the tibia already looks and feels like normal tissue. Even its temperature has for the most part been re-established. At this time, all the sutures can be removed and the leg redressed by the application of a single layer of peerolatum gauze and more sterile dressings and re-bandaged. The patient is then returned to bed for a week. He is



FIG. 26. Case III. Previous injury six weeks after dermoplasty. Note return of hair growth and fine condition of "bridge" over tibia. The medial suture line is almost imperceptible. In this case, the free skin graft lateral to tibia was not absolutely full thickness, in that a film of it was shaved off when the fat was being removed. Consequently, the cosmetic appearance is not as good as in the previous case.

illustrated in Figures 23 and 24, taken at the end of twelve and twenty days, respectively.

These patients, other things being equal, are ready for definitive orthopedic work forty to sixty days after dermoplasty. (Fig. 13.)

#### SUMMARY

A method composed of recognized surgical procedures is herein presented for the best physiological revision of war wounds of the lower leg, based upon selected and

proven principles of plastic surgery. The method is detailed and illustrated.

Its purpose is maximum revision of soft tissue deformity to give optimum conditions for subsequent orthopedic or plastic reconstruction and functional rehabilitation.

The method consists of absolute excision of all soft tissue disorders followed by the best available combined methods of grafting defects. It additionally reduces to a minimum the use of extensive free grafting, which is not the best method of tissue replacement for functional as well as cosmetic reasons. This is made possible by the combination of a double pedicle flap, with a reduction in the circumference of the leg, and the secondary use of full thickness skin over a small residual surgically created area.

It has been shown by this method that a complex injury to the lower leg can with more speed and better results be reduced to a simple closed wound or fracture in preparation for ultimate rehabilitation of the patient.

#### CONCLUSIONS

1. Direct free grafting of extensive ulcerating or diseased areas *per se*, as is

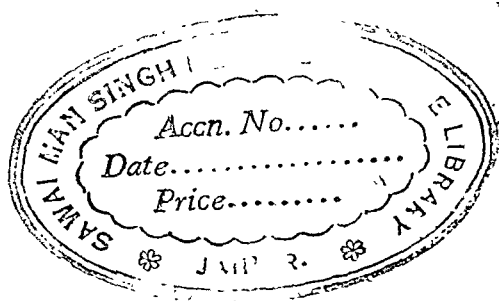
the common practice, is physiologically insufficient, anatomically inadequate for subsequent major surgery, functionally problematical and cosmetically of little promise.

2. The use of single pedicle flaps, especially from the contralateral extremity, though more promising, is yet not the best available practice and should, therefore, only be employed where no better choice exists.

3. The method herein described, employed with good results in fifty unselected cases, has proved superior to others more commonly employed.

4. Because of the physiological integrity and anatomic completeness of the method, the period of hospitalization has been materially reduced. It is believed that eight to ten months' time is gained in the surgical management of certain difficult injuries of the lower extremities.

5. Based upon a fair quantitative application of the herein described method, it is the author's final conclusion that in severe war wounds especially and in other forms of lower extremity defects possibly, such a method of procedures yields far better and quicker results than other methods more commonly practiced.



# ANATOMICAL AND FUNCTIONAL REDUCTIONS OF FRACTURES OF THE PELVIS

F. WALTER CARRUTHERS, M.D.

Diplomat of the American Board of Orthopedics; Chief of Surgery, St. Vincent Infirmary  
LITTLE ROCK, ARKANSAS

**A**NATOMICALLY, the pelvis is singularly important as a very large portion of the bony network of the body. It is a strong rim of bones which supports the lower spine and transmits the weight of the upper trunk to the lower extremities. In addition, it offers support for the protection of the pelvic viscera; and still further, the pelvic bones serve as points of attachment for certain ligaments and muscles that play a part in the movement of the lower extremities as well as the trunk.

The pelvis is composed of several bones: the ilium, ischium, pubis, sacrum and coccyx. At this point, I must stress that there is a definite anatomical difference between the male and the female pelvis. The pelvis of each sex performs similarly the functions mentioned before. The female pelvis, however, is dedicated to an important rôle in the successful culmination of pregnancy. We must recognize clearly that this difference does exist and be cognizant of this fact when injuries of the pelvis are presented to us for treatment.

These bones, in their proper anatomical relation, form a cavity divided into an upper false and a lower true pelvis. In their complete anatomical set-up, they are subjected to many types of fracture. We may have a fracture of the wing of the ilium, a fracture of the superior spine of the ilium, a fracture of a single ramus of the ischium or both, a separation of the symphysis pubis, a fracture-dislocation through the sacroiliac joint, a fracture of the sacrum, or a fracture of the acetabulum associated with dislocation of the head of the femur and fracture of the coccyx. Any of these fractures may be single or multi-

ple, although 65 per cent of pelvic fractures are multiple.

All injuries to the pelvis, whether severe or mild, should be subjected to a careful physical examination, including a diligent roentgenographic study. This procedure is of two-fold importance: first, to detect, if possible, the presence of any fractures or fracture-dislocations; and, second, to avoid a possible error in diagnosis, since the pelvis is so well covered with soft tissue that an accurate diagnosis by physical examination in many instances is impossible.

Associated with fractures of the pelvis we find many complications. Most frequent of these is damage to the soft parts, occurring in 16 per cent of the cases. Ten per cent of all pelvic injuries are associated with lesions of the urinary tract, such as rupture of the bladder, the urethra, or both. Temporary ileus may further complicate the injury. Less frequent are tears in the vaginal wall and injuries to the rectum. In one case, this former complication occurred in the upper vaginal wall. Severe abdominal viscera injury and even possible injury to the sacral and obturator nerves are to be thought of and ruled out. Nerve lesions involving the sciatic trunk are very rare. If the injury is compounded, a later complication, especially osteomyelitis is likely to develop. This complication has been brought to our attention in a recent article by Dr. H. Winnett Orr.<sup>1</sup> In the series presented here, only one patient developed this complication.

Statistics show that a large percentage of fractures of the pelvis are accompanied by injuries to the structures mentioned, and a

final diagnosis cannot be made until all of these possibilities are ruled out.

When rupture of the bladder occurs,

If, with the patient lying in a prone position, when firm pressure is made upon each side of the pelvis by grasping the wings of

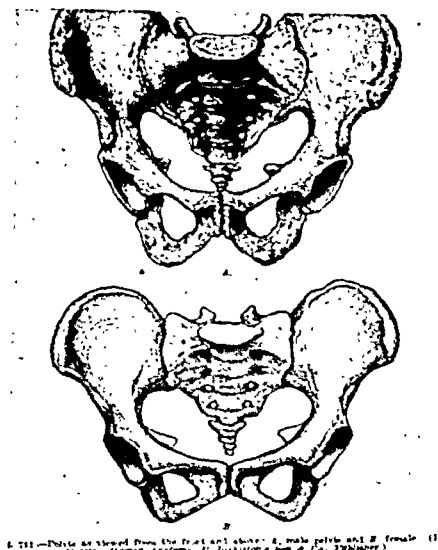


FIG. 1. Shows anatomical contrasting species of male vs. female pelvis. (From Morris' "Human Anatomy," P. Blakiston's Son & Co.)

although the lesion is usually extraperitoneal, it may be intraperitoneal. This complication cannot be ruled out until the patient has voided clear urine, or the condition of the urinary tract has been more completely investigated by catheterization or even cystoscopic examination.

A patient with an injury to the pelvis should be very thoroughly examined to determine how seriously he may be injured and whether an open operation, other than reduction of the fracture, is indicated. Immediately after admittance to the hospital, if the patient is not too seriously in shock, roentgenograms should be taken with meticulous care and consideration. This should be followed by a painstaking examination to determine the condition of the soft parts or other injuries. If the patient is not in severe shock, appropriate measures should be followed by the securing of a specimen of urine and, if necessary, by catheterization. The presence of abdominal pain, with rigidity and dullness in one or both flanks may or may not mean intra-abdominal complications.



FIG. 2. This represents the plaster cast applied to the lower limbs in fractures of the pelvis in which a Roger Anderson well leg splint has been incorporated. It also shows the turnbuckles as used in applying them to the plaster cast in the treatment.

the ilia and pressing the hands together, there is complaint of pain in the pelvis, it is not infrequently pathognomic of a fracture of some of the bones of the pelvis. Certainly, with this finding, the attention should be directed to the pelvis for a thorough inspection for deformity and swelling. It is almost axiomatic to avoid violent manipulation, and to depend upon the roentgenogram for the final diagnosis as to the presence of a fracture.

Following the careful examination and confirmation of the diagnosis, the attention should be directed to the treatment which will best restore complete normal function or approach it as nearly as possible. The importance of this restoration of function differs in the male and female pelvis. In the male, a normal weight bearing pelvis may be all that is necessary to restore function and permit the patient to re-enter his previous occupation as the wage earner

of the family. In the female all this is true; but, in addition, there is a very different function to be performed by her pelvis,

it may constrict the pelvic outlet and interfere with delivery.

"We believe that one should not adopt



FIG. 3. Shows a complicated fracture of the pelvis involving both rami, and a fracture through the fracture and separation through the posterior part involving the sacroiliac joint; before treatment.



FIG. 4. End result of fracture shown in Figure 3. This patient delivered a normal baby by a midwife.

the normal restoration of which is of very great importance to her, especially if she is of the child-bearing age. In my humble opinion, I know of no other group of fractures which requires keener surgical judgment throughout the course of treatment than these severe and complicated fractures of the pelvis, especially in the female. It is not enough merely to save the lives of these women and to enable them to walk upright. Their pelvic bones must be restored anatomically to permit normal gestation and delivery.

Caldwell,<sup>2</sup> of Cincinnati, back in 1919, described his treatment with sand bags, Buck's extension and attempts at reduction of the fractures through the vagina or the rectum. He stated, "In women who expect to bear children, the deformity must be corrected if it is humanly possible to do so." In this statement, I agree with him one hundred per cent. I do not approve of his method.

Key and Conwell,<sup>3</sup> commenting on this subject, said, "It is the opinion of many obstetricians that the position of the fragments in fractures of the pelvis is of considerable importance as regards future pregnancies. It is true that, if a woman has a very bad position in the pelvic fracture,

any unusual method in an effort to obtain perfect position of the fragments in fractured pelvis in women in order to retain the normal pelvic outlet. In other words, fractures of the pelvis in women should be treated in the same manner as fractures in men and, if necessary, a cesarean operation can be performed should the occasion arise."

I do not agree with this. If it is humanly possible, and I believe it is, to reduce the most severe fracture of the pelvis in the female to such an extent that it will not be necessary to subject motherhood to cesarean section, then our efforts are truly worth while. One should not be content to accept unreservedly the recommendation of cesarean section which our present day authors would have us adhere to, a procedure which is to me, for the most part, not acceptable.

It is my belief that the types of severe pelvic injuries that have come to my attention have been treated in a far more scientific manner than the present-day accepted technic, with results which justify this conclusion. I believe that one should devote himself assiduously to the prevention of residual deformities and disabilities, especially in a female, because her pelvis

is to be called upon to perform the duties incumbent in childbirth.

One is at all times confronted with the

mant in the face of the older, generally accepted beliefs. We cannot lean too strongly in any direction, but we can search



FIG. 5.

FIG. 5. Shows a complicated fracture of the female pelvis, rami on both sides and posterior fracture dislocation involving the sacroiliac and that portion of the ilium in that vicinity; before treatment.



FIG. 6.

FIG. 6. End result of the fracture shown in Figure 5, two years after treatment. This patient delivered a normal baby by a midwife.

problems of anatomical and functional restoration of the fractured parts. This is particularly important in those cases in which the fragments have been severely distorted and marked deformity of the pelvis is present.

A thorough study of carefully made roentgenograms is necessary in order to know the type of fracture present and thus to be able to decide upon the best plan of treatment. The method of choice should be that which will best restore and preserve the normal continuity of the pelvis with particular emphasis upon the anatomical restoration of the pelvic ring. Such restoration will obviate sequelae which may appear a year or more later. These would involve the posterior region of the pelvis, sacroiliac and lumbosacral joints. Proper treatment will prevent these complications.

The restoration of the normal pelvic outlet, both in the male and female, is far more important than has heretofore been stressed and emphasized in the literature. It is not enough to save the lives of these patients. We must pay more attention to the prevention of disability.

In the practice of medicine, we must not allow our empirical tendencies to lie dor-

for newer and better methods than those at our immediate command. It is up to us to evaluate newer concepts and, if these prove to be more acceptable, we should discard the older ones. "Be not the first to lay the old aside, nor yet the first by whom the new is tried."

Certainly the restoration of a fractured pelvis to its normal contour has not been stressed properly in former writings. We have been too prone to be satisfied with results, particularly in fractures of the male pelvis, which permits the individual, in spite of marked residual deformity, to carry on his occupation.

Another author, bearing this out, stated, "Attention is called to the excellent results, but no improvement was accomplished as regards the position of the displaced fragments."

Statistics show that 90 per cent of fractures of the pelvis prior to 1923 occurred in the male. Since 1923, fractures of the pelvis in women have amounted to almost 50 per cent of the total civilian cases. Seventy-five per cent of these pelvic fractures in women were received in automobile accidents. Fractures of the pelvis are no longer merely industrial in origin but more and

more are resulting from automobile accidents. This change has resulted in more fractures of the female pelvis and certainly

in ages from twenty-five to thirty-five years. I must emphasize again, this is an age period very important to the female



FIG. 7. Is a complicated fracture, the first one treated by this method under my care. Notice the marked distortion of the pelvic outlet.



FIG. 8. Shows the end results five years after treatment, with mild distortion but with a normal pelvic outlet. This patient has had three normal deliveries; no cesarean section was necessary.

should have brought with it a different conception on our part concerning the importance of restoration of the female pelvic outlet to normal.

This presentation is based upon my own observation and treatment of sixty-six patients. The majority of these involved isolated injuries to the pelvic ring, combined injuries to the pubic segment, and combined injuries to the pubic and iliac segments of the pelvic ring. There were two cases of fracture of the acetabulum associated with dislocation of the head of the femur and one severe complicated fracture of the pelvis with complete dislocation of the femoral head. It is a well known fact that most pelvic fractures involve the pubic segment of the pelvic ring. These heal satisfactorily. On the other hand, combined fractures of the pubic and sacroiliac segments are likely to result in serious disabilities unless the displaced fragments are correctly reduced. Fractures of this type require careful evaluation of the damage and meticulous care and treatment to secure an end result which will be both anatomically and functionally satisfactory.

Early in the spring of 1935, I saw three patients of this series, all women, ranging

pelvis because of the function of childbirth. I cannot definitely state whether the importance of this function had been profoundly impressed upon me prior to this time.

One of the patients asked, point blank, "Will it be possible for me to deliver a baby through my distorted pelvis?" This young woman, twenty-five years old, and a mother of two children at the time, had sustained a severe, crushing fracture to the pelvis which involved both sides of the pubic segment, superior and inferior rami, producing a very severe deformity. The x-rays showed an extremely distorted outlet of the pelvis. If this were left in the original position, although it probably would unite, normal childbirth would have been impossible.

We undertook to set this fracture in the manner which had been employed in the treatment of earlier cases: the Bradford frame was used with the patient supported in a canvas hammock, according to Conwell's method, with Buck's extension to both legs, or, as has been recently emphasized by R. Watson-Jones, by a process of immobilization of the pelvis in lateral recumbency.



Careful x-ray check-up failed to show satisfactory reduction. The method of treatment advocated by Dr. S. A. Jahss, of New York, was then used. This method employs the use of the lever principle of reduction. This is brought about by the application of plaster casts to both limbs from the groin to include both feet in which three turnbuckles are incorporated.

In a series of forty-three cases, of which twenty-one were female and twenty-two male, all, with the exception of three have been treated by the basic principles advocated by Dr. Jahss or a modification developed from my own experience with it. In those severe cases in which there was an involvement of the pubic segment of the pelvic ring on both sides anteriorly or extensive fracture through the segment of the pelvic ring on both sides anteriorly or extensive fracture through the posterior portion of the sacroiliac joint, we found it necessary to incorporate more traction. To accomplish this we utilized the Roger-Anderson well leg splint along with the use of the turnbuckles. In those cases in which we used the Roger-Anderson well leg splint and the turnbuckle combined, only two turnbuckles were found necessary. As stated before, when the Roger-Anderson splint is not indicated, three turnbuckles are used.

The only indications for the use of the Roger-Anderson well leg splint are in those cases in which it is deemed necessary to have a great deal of traction in order to bring the upward-displaced and distorted pelvis down to its normal position. With the use of the turnbuckles, it is possible, by the leverage action, to spread the pelvic ring and restore the pubic fragments into anatomical position, thereby restoring the pelvic ring, anatomically. In the female, as stated before, this is paramount and can be accomplished by either method, depending on the type of fracture.

In those cases in which the Roger-Anderson well leg splint is not employed, we use the three turnbuckles and manipulate until the desired effect is attained

from the application of the turnbuckles into the plaster cast, which is applied only from the groin down to and including the feet. We have never found it necessary in any of our cases to immobilize or apply bandage, plaster, canvas strips or adhesive about the pelvis. Following the reduction, the patient is able to sit up in bed or be rolled about in a wheelchair as desired.

There has not been a single case in this series in which we have not been able to restore the anatomy of the pelvis completely and satisfactorily. We have the good fortune to be able to show you in two of these cases a fetus in the pelvis, prior to the delivery, and the condition of the pelvis after delivery. (Figs. 3 and 4.) In both of these cases, prior to pregnancy, there was a severe type of multiple comminuted fracture, including a complete breakdown of both rami, and a fracture posteriorly adjacent to the sacroiliac joint. One of these patients, a colored female, was delivered by a mid-wife without cesarean section and without complications.

There should be no occasion for authors, in writing in the future, to have to report as one did recently, in speaking of the Jahss method: "A. S. Jahss reported a method of treatment of fractures of the pelvis in the *Journal of Bone and Joint Surgery*, in which two turnbuckles imbedded in plaster cast, extending from the groin to the end of the toes on both legs were used to overcome the protrusion of the femoral head into the pelvis. This method, he says, has attractive features, but the necessity of considerable pressure against the sides of the thighs, and the fact that traction, which is important in the restoration of the joint space cannot be applied, seems to develop serious defects in this method. We have no experience with this form of treatment, however, and so cannot speak with any authority as to its effectiveness."

One should not be too prone to criticize unless he has thoroughly tested the method in question or at least is acquainted with the subject under discussion.

The title of Dr. Jahss's paper, *Injuries Involving The Ilium*, was probably misleading. However, the method of treatment advocated and offered by him has been the principle on which we based our endeavors. With certain modifications, we have been able, by meticulous care, to reduce and restore fractures of the pelvis coming under our care completely and anatomically. Since 1935, I have continued to use the turnbuckle principle in the treatment of all patients with fractures of the pelvis, by applying Dr. Jahss's basic principle.

Our technic is very simple, so simple in fact that we have never found it necessary to administer an anesthetic for the actual reduction of the fracture itself. This is in marked contrast to the usual surgeon's technic, in which deep to profound anesthesia is recommended.

The patient, for the reduction, is taken to the plaster room or the surgical room in the hospital where the plaster cast is applied to both limbs from the groins down to the tip of the toes, in which three turnbuckles are incorporated and adjusted mechanically. In cases in which the Roger-Anderson well leg splint is to be used, this is applied according to the same basic method but is followed by the incorporation of two turnbuckles instead of three. In our use of the turnbuckles, which may be purchased at any hardware store, we have found that the addition of a right angle bar to the end of the turnbuckle for incorporation into the plaster cast makes for a firmer and a more secure fixation. Following whatever method of application that may have been used, after the cast has become firmly set, the turnbuckles are then adjusted to accomplish the reduction. This can be done without anesthesia, as in all our cases.

The turnbuckle principle has a range of usefulness far greater than for injuries involving only the ileum or for treatment of fractures of the acetabulum with central dislocation of the femoral head. In three cases in which we had dislocations of the

femoral head associated with fractures either in the acetabulum or involving the ramus, and in one in which there was severe fracture through the sacroiliac region, by using the Roger-Anderson well leg splint and two turnbuckles on the first three cases, and three turnbuckles alone on the other, we completely reduced the fractures in question.

It is my firm conviction that a series of sixty-six cases, the majority of which were of the most severe types, is sufficient material from which to reach definite deductions and conclusions as to the merit or demerit of the method advocated here. I am firmly convinced that all overhead frames, canvas hammocks, canvas strips, Buck's extension, posterior shells and plaster immobilization of the trunk and lower limbs advocated and used in the past for treatment of fracture of the pelvis can be relegated to the dump heap. This statement is not based on enthusiasm but is a practical appraisal of the results achieved.

It is my further opinion that fractures of the pelvis should be given careful consideration with thoughtful evaluation of the damage done, and certainly meticulous treatment is necessary to secure satisfactory end results that will meet all future requirements.

Both Jahss's method and the method of incorporation of the Roger-Anderson well leg splint have been referred to in the literature prior to this time. Paul B. Magnuson, in his second edition on *Fractures* has mentioned a somewhat similar method, using a board in place of a turnbuckle. The use of the Roger-Anderson well leg splint was referred to in literature in 1939. I have been using all of these methods since 1935, but have not heretofore presented my results, as I have wanted to be satisfied with the principle, based on a sufficient amount of material to be incontrovertible. At the same time, I have wanted to be thoroughly convinced that this series has ample merit and has produced results satisfactory enough to warrant its presentation.

No attempt is being made here for priority or any other claim on these methods. The only thought is to offer to you further suggestions and conclusions on the treatment of these fractures.

In conclusion, it is my opinion that these methods are sound, logical, and meet all the basic mechanical requirements needed to restore the pelvis anatomically. Functional result will follow anatomical restoration in any and all types of fractures, from the simplest to the most complicated. If we remember that fractures of the pelvis must be treated by the same principles as fractures elsewhere, and, too, if we remember that these injuries, serious as they sometimes are, may and can be greatly relieved and even completely restored to normal function by the application of sound mechanical reason, well applied, a great deal, if not all the apprehension felt by both the surgeon and the patient can be entirely relieved.

## REFERENCES

1. ORR, H. WINNETT. Osteomyelitis and compound fractures of the pelvis. *Surg., Gynec. & Obst.*, vol. 54, April, 1932.
2. CURRY, G. J. Fractures of the pelvis, management by use of posterior plaster-of-paris shell. *J. Bone & Joint Surg.*, April, 1939.
3. CONWELL, H. EARLE. Fractures of the pelvis: a summary of treatment and results attained in 185 cases. *Surg., Gynec. & Obst.*, February 15, 1933.
4. DICKSON, FRANK D. Injuries to the bony pelvis. *South. M. J.*, May, 1939.
5. JAHSS, S. A. Injuries to the ilium: a new treatment. *J. Bone & Joint Surg.*, April, 1935.
6. KOSTER, HARRY and KASMAN, LOUIS P. Treatment of fractures of the pelvis. *J. Bone & Joint Surg.*, October, 1937.
7. McCONNELL, W. T. Cephalo-pelvic disproportion, with special reference to borderline pelvis. *South. M. J.*, July, 1939.
8. O'DONOGHUE, ARCH F. Fractures of the spine and pelvis. *Lancet*, Minneapolis, June, 1939.
9. SCHAAP, C. Intrapelvic protrusion of the acetabulum. *J. Bone & Joint Surg.*, October, 1934.
10. CARRUTHERS, F. WALTER. Anatomical and functional results in fractures of the pelvis. *South. M. J.*, April, 1938.
11. WATSON-JONES, R. Text Book. Fractures and Other Bone and Joint Injuries. P. 263, 1940.



# EVOLUTION OF GASTROSTOMY

JULIUS L. SPIVACK, M.D.

Associate Professor of Surgery, University of Illinois College of Medicine  
CHICAGO, ILLINOIS

**T**HOUGH gastrostomy is one of the oldest gastric operations, certain difficulties connected with its execution are not yet overcome. This may explain why so many methods have been described; of these few have new features, while others are merely a rediscovery of old methods, which became obsolete and were entirely forgotten. Some methods were not sufficiently publicized at the time of their introduction but later were rediscovered and by able presentation became widely used. In several instances the authors used identical words for different ideas and methods, which proved a source of confusion to some writers who did not see any difference in the methods because of the similarity in their wording. It is obvious, therefore, that a historical review of the most important methods and their evolution is timely.

## HISTORICAL NOTES

This operation is one of the earliest performed on the stomach. It was first performed by Daniel Schwaben,<sup>1</sup> in 1635, for removal of a knife, accidentally swallowed. It was an intended gastrotomy, but a gastric fistula was formed, thus becoming a gastrostomy. Several cases<sup>2</sup> of traumatic gastrostomies were known in the eighteenth century; some of these patients lived for decades, taking food through the gastrostomy opening and evidently enjoying good health. To Christian A. Egeberg<sup>3</sup> belongs the credit of being the first who suggested it as a planned operation for feeding the patient in case of impermeable esophageal strictures and who in 1837 presented a paper on this subject before the Christiania Medical Society. He not only suggested the operation, but gave an outline of its

surgical technic, which for many decades was followed by surgeons.

Bassow,<sup>4</sup> in 1842, made several gastrostomies on dogs, and Blondot<sup>5</sup> at about the same time also did it on dogs for physiologic investigations. The first who performed it on a human being was Sédillot, of Strassbourg, who performed his first operation<sup>6</sup> in 1849 and the second<sup>7</sup> in 1853. He used a metallic cannula and covered it with a cap, to prevent the escape of gastric contents outside. After that this operation was done in different countries. The first case in Denmark and the third on record was done by E. Fenger,<sup>8</sup> of Copenhagen in 1853. He was the first to introduce the left oblique abdominal incision running parallel to the left costal arch and which is known since that time as "Fenger incision."

In England, it was done for the first time in 1858 by J. Cooper Forster,<sup>9</sup> in Germany by VanThaden,<sup>10</sup> of Kiel, in 1866, in the United States by F. F. Maury,<sup>11</sup> of Philadelphia, in 1869, in Russia by N. W. Sklifassofski,<sup>12</sup> in 1879.

The first successful gastrostomy is usually attributed to Sydney Jones,<sup>13</sup> of London, whose patient, operated upon in 1875, lived forty days following the operation.

The first successful case in France was done by Verneuil,<sup>14</sup> in 1876, on a young man, age seventeen, who swallowed corrosive material. The first successful gastrostomy in Germany was done by Schoenborn,<sup>15</sup> in 1876, whose patient died three months after operation. Some writers unaware of Schoenborn's case attributed the first successful gastrostomy in Germany to Trendelenburg,<sup>16</sup> who operated in 1877 on an eight-year old boy who swallowed corrosive material. The child recovered

Several difficulties confronted the surgeons of those days, among which the most important were leakage of gastric contents and peritonitis. Among other complications arising from time to time was the detachment of the stomach from the abdominal wall and slipping back into the peritoneal cavity; the colon occasionally was mistaken for the stomach and colostomy was done instead of gastrostomy. All these difficulties were overcome in a comparatively short time with the exception of leakage of gastric contents. Many ingenious devices were offered to overcome this difficulty. All these methods can be classed into several groups.

#### CLASSIFICATION OF METHODS

All the procedures described can be grouped into several classes:

*I. Formation of a Gastric Cone, the Base of Which Is Attached to the Abdominal Wall.* This is the oldest method of gastrostomy. It was practiced by Sédillot,<sup>6,7</sup> Fenger<sup>8</sup> and other pioneers in gastrostomy. It is characterized by pulling out a small gastric cone and by suturing its base circularly to the parietal peritoneum. The surgeons relied upon contractibility of the muscles of the gastric wall and on redundancy of the gastric mucosa plugging the gastric opening and making the stomach water-tight. However, if the opening of the stomach was made large or if the mucosa was shallow the contents leaked and for these reasons this group gave way to other groups. This group has several variations:

1. Utilization of the rectus muscle as a sphincter compressing the cone. This factor serves as an additional aid to previously described factors in making the stomach water-tight. However, it does not always accomplish it.

a. Method of von Hacker,<sup>17</sup> described in 1886: It consists of carrying a cone from the anterior gastric wall through the split fibers of the left rectus abdominis muscle. It was hoped that these fibers will compress the gastric cone efficiently and make

the stomach water-tight. However, it did not prevent leakage. Though this method is usually credited to von Hacker, it was done long before him. Troup<sup>18</sup> operated by this method in 1867, Maury<sup>11</sup> in 1869, Schoenborn<sup>15</sup> in 1878, to mention only a few.

b. Girard<sup>19</sup> method, described in 1888: He opened the abdomen longitudinally by a left midrectus incision, split a portion of the left rectus muscle on each side of the opening making on each side a muscular band 2 cm. wide and 10 cm. long. Then he lifted these band-like portions and crossed each other at their extremities so as to form a sphincter and fixed the end in such position by suturing. Next, a gastric cone was brought outside the abdomen through this sphincter, the base of which was sutured to the circumference of the sphincter; the apex of the cone was opened and a rubber tube inserted.

2. Utilization of cartilages of adjoining ribs as a stop-cock—Hahn<sup>20</sup> method: The abdomen is opened and a portion of the anterior gastric wall is selected; this is carried outside through another opening made between the cartilages of the left eighth and ninth ribs. He expected these cartilages to act as a stop-cock.

3. Carrying of the gastric cone through oblique channels through muscles, fascia or under the skin. This principle of forming a tortuous instead of a direct canal is one of the most effective methods of preventing leakage.

a. Ssabanejev<sup>21,22</sup> method and its modifications (Jaboulay,<sup>23</sup> Lucy<sup>24</sup>): In this method a gastric cone is brought outside the abdomen through a Fenger incision. A small skin incision 3 cm. long is made in the sixth or seventh intercostal space at the left mamillary line. The skin is undermined from this incision until it reaches the abdominal incision and a portion of the anterior gastric wall is carried through the subcutaneous channel so that 1 cm. of the stomach is brought outside the small incision. The stomach is sutured to the parietal peritoneum and the abdominal

wall is closed. The apex of the cone is opened and its lips are sutured to the skin. A catheter is introduced whenever feeding should be done. The rest of the time there is a bandage compressing the gastric cone to the bony chest wall. The drawback to this method is that it requires a large stomach, whereas, as a rule, whenever gastrostomy is needed the stomach is small and contracted. This method of Ssabanejev was reported by Vinokurov in 1890. Rudolph Frank,<sup>25</sup> of Vienna, not knowing of the work of Ssabanejev, described it in 1893. However, the priority belongs to Ssabanejev.

b. Hartman<sup>26</sup> method, described in 1897: The abdomen is opened by a left paramedian incision and a gastric cone is brought outside the abdomen, then carried laterally *behind* the rectus muscle and then brought forward through the rectus muscle split in its middle third, so that the skin opening is about  $2\frac{1}{2}$  cm. away from the midline. Thus the fistulous tract is compressed at two places: between the rectus muscle and its posterior sheath and between the fibers of the left rectus abdominis muscle.

4. Torsion methods in which the gastric cone is rotated axially.

a. Ullmann<sup>27</sup> method, employed in 1894: The gastric cone is brought outside the abdominal cavity and torsion of 180 degrees is made, then suturing the base of the twisted cone to the parietal peritoneum. The apex of the cone is then opened and the lips are sutured to the skin.

b. Souligoux<sup>28,29</sup> method, published in 1902: It consists of two twists: one is made of 180 degrees as soon as the stomach is brought outside the abdominal cavity and the base of the twisted cone is sutured to the parietal peritoneum; another twist of 120 degrees is made and the cone sutured to the anterior sheath of the rectus muscle; the apex of the cone is then opened and the lips are sutured to the skin.

c. Heflerich<sup>30</sup> method, described in 1895: It is a combination of a Ssabanejev and Ullmann's method. The operation is done

exactly as in Ssabanejev's method with this difference only that the apex of the gastric cone brought outside the small subcutaneous opening on the chest is rotated at 180 degrees, opened and sutured to the lips of the skin.

II. *Formation of a Channel from the Anterior Gastric Wall.* The general principle of this group consists of making a channel from the anterior gastric wall which is lined with serosa. While this adds to the water-tightness of the stomach, it introduces an objectionable feature, namely, the channel lined with serosa has a tendency toward obliteration. This general group can be subdivided into several subgroups:

1. Formation of a channel by suturing a portion of gastric wall over a rubber tube. The channel lies horizontally.

a. Witzel<sup>31</sup> method, described in 1891: A portion of the anterior gastric wall is delivered outside the abdominal cavity. A small opening is made in the anterior gastric wall through which is inserted a rubber tube for a distance of one inch. The rubber tube is placed on the gastric wall in a direction upward and to the left; two folds of the gastric wall are sutured over the rubber tube for a distance of 4 cm. Thus the opening into the stomach occupies the lowermost portion in the channel and resembles the course of a ureter.

b. Gernez<sup>32,33</sup> modified the Witzel method in this respect that he placed the opening on the fundus, so that the opening into the stomach occupies the highest point of the channel.

2. Formation of a channel lined with serosa by invagination of the cone by a purse-string suture (Stamm) or by Lembert suture (Fontan, Kader). The channel lies vertically and the opening into the stomach is at its bottom.

a. Stamm<sup>34</sup> method (Figs. 1 and 2), described in 1894: The abdomen is opened and a portion of the anterior gastric wall is delivered outside. A circular purse-string suture is made with a radius of

one inch. The stomach is opened at the center of this circle and a rubber tube No. 15 American scale is inserted for

same feature is the main objection for permanent gastrostomy.

b. Fontan<sup>35,36</sup> method (Fig. 3): The



FIG. 1. Stamm method of gastrostomy. A, seromuscular purse-string suture; B, opening of the stomach, insertion of a catheter and its transfixion by a catgut suture; C, tying the ends of the purse-string suture.

a distance of one inch and the tube fastened to the gastric lip by a silk or catgut suture. The purse-string suture is drawn together and the ends are tied. Six interrupted sutures fasten the stomach to the parietal peritoneum; each end of the purse-string suture is passed through the entire thickness of the corresponding abdominal lip and both ends tied to each other. The good features of this method are that it has a simple technic and that the channel has a tendency toward spontaneous closure which is good for a temporary type of gastrostomy. However, the

abdomen is opened and a gastric cone is sutured at its base to the parietal peritoneum along the entire circumference of the cone. The apex of the cone is then grasped by a forceps and the cone is invaginated, like a finger of a glove with the forceps being used as an axis. The contacting crests of the fold on each side of the forceps are sutured to each other by a series of interrupted sutures and the forceps is withdrawn. A knife is introduced into the channel where the forceps was before and the base of this channel is cut; a rubber catheter is introduced and fixed

to the stomach at the upper end of the channel.

c. Kader<sup>37</sup> method: It consists of insert-

efficient, as in all of them with exception of the Andrews' the lumen of the channel is not lined with mucosa and, therefore,

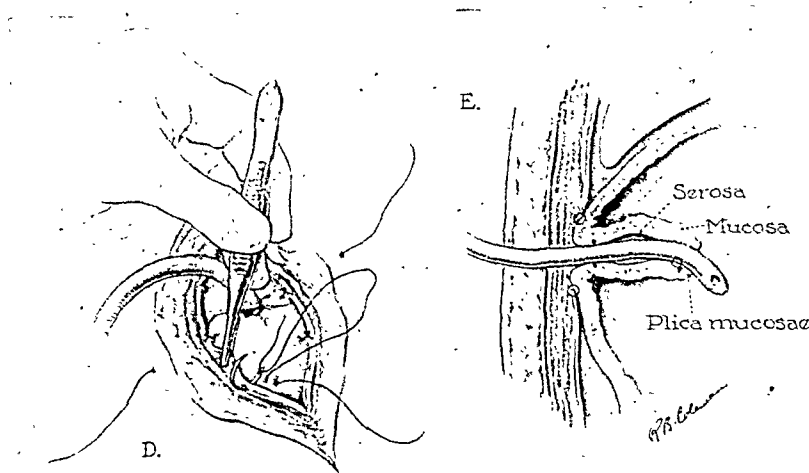


FIG. 2. Stamm method of gastrostomy. D, fixation of the base of the gastric cone to the parietal peritoneum; E, cross-section, showing the catheter passing through the anterior abdominal wall and gastric channel lined with serosa.

ing a rubber tube into the stomach, transfixing it to the anterior gastric wall and forming a channel by suturing to each other the crests of two vertically placed folds, one on each side of the rubber tube.

Comparing these three methods (Stamm, Fontan and Kader) we can see that *they are identical*: in each method we have a *vertical channel* lined with serosa at the bottom of which is the opening leading into the stomach. (Compare Fig. 2E with Fig. 3D.) The minor technical differences are only that Stamm forms the channel by a purse-string suture, Fontan by vertical Lambert and Kader by horizontal Lambert. *The priority belongs to Stamm.*

3. Intramural methods. The characteristic feature of this group is that a channel is established in the thickness of the gastric wall through which a catheter passes into the lumen of the stomach. It was hoped by originators of this group that the channel will not obliterate because it is not lined with serosa and that it will be water-tight on account of valvular action of the gastric wall.

However, these methods did not prove

still retains the tendency to obliterate. The method of the Andrews' overcomes both these difficulties, as it runs intramurally and is lined with mucosa. In the time of its description in 1894 it was the most efficient though technically the most complicated method. However, the tubular methods and particularly the tubovalvular method accomplished the same in a simpler way. To this group belongs the methods of Andrews and Andrews,<sup>38</sup> Marwedel,<sup>39</sup> Schnitzler,<sup>40</sup> Fisher<sup>41</sup> and recently Soresi<sup>42</sup> (1937).

a. E. Andrews and E. Wyllys Andrews<sup>38</sup> operation: The abdomen is opened and a portion of the anterior gastric wall is brought outside. A longitudinal incision two inches long is made on the anterior gastric wall, starting from the upper part of the exposed stomach. A portion of the anterior gastric wall just below the incision is delivered through the gastric incision and spread out flat. From the lower end of the cut, two incisions are made through mucous membrane, one to the right and the other to the left, each extending about three-quarters of an inch laterally from the lower end of the main incision. From the



end of each of these two mucous membrane incisions, another incision is made downward through the mucous membrane

each other over the previously formed tube, thus transforming it into an intramural channel through the lumen of which

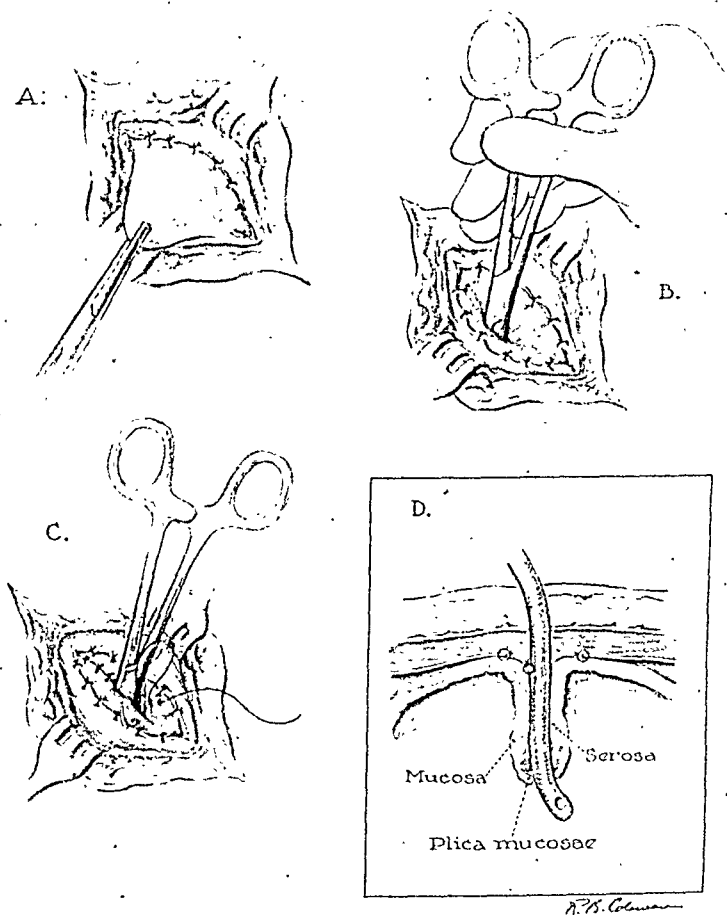


FIG. 3. Fontan method of gastrostomy. A, fixation of gastric cone to the parietal peritoneum; B, inversion of the cone as a cavity of a Bishop's mitre; C, seromuscular suturing of the crests of two folds; D, cross-section, showing catheter passing through the anterior abdominal wall and through a gastric channel lined with serosa. Note that this method is identical with Stamm's, as is clearly seen from their respective cross-sections.

parallel to each other and to the axis of the body for a distance of one and one-half inches. At the lower ends the two incisions are turned at a right angle toward each other, but not meeting, a separation of one-third of an inch being left between them. Next, a rubber tube, No. 10 English catheter scale is laid on this quadrangular mucous flap and the edges of the flap are sutured to each other over the catheter, thus forming a tube. The edges of the retracted mucosa are sutured to

passes the rubber tube. The opening in the stomach is then closed.

b. Marwedel<sup>39</sup> method: The abdomen is opened and a portion of the stomach is delivered outside. A seromuscular incision is made on its anterior wall midway between the greater and lesser curvatures and parallel to them. Each seromuscular lip is separated from the underlying mucosa, thus procuring a wide mucosal bed for the rubber tube; a small opening is made through the mucosa and a rubber tube

introduced through it into the lumen of the stomach. A transfixion suture is placed on the tube and the mucosa; the tube is laid upon the mucosa and the seromuscular lips are sutured to each other over it.

*III. Utilization of an Already Existing Tubular Structure in the Abdominal Cavity Lined with Mucosa.* To this group belong the method of Tavel<sup>43</sup> who utilized a jejunal loop and Kelling's who utilized a loop of transverse colon. This group has no advantages over the previous one; as a matter of fact they are not as water-tight and technically they are more complicated.

a. *Tavel method:* After the abdomen is opened a high jejunal loop two inches long is resected leaving it attached to its mesentery. The continuity of the intestinal tract is re-established by an end-to-end anastomosis. The aboral end of the resected loop is implanted into the anterior gastric wall and the oral end is brought outside the abdominal cavity. Being lined with mucosa this tube will not obliterate. However, this method does not prevent leakage and being a method of some technical magnitude it did not find many followers.

*IV. Tubular Methods in Which a Tube is Formed from a Flap of a Gastric Wall.* A common feature of all these methods is that the tube is lined with mucosa and for this reason does not obliterate. These methods depend for their water-tightness upon the sphincteric action of the abdominal wall muscles and on the size of the mucosa of the stomach which blocks the base of the tube. The weak point of this group is that in making the tube the compressing action of the gastric wall which contributes to water-tightness is lost.

Among the variations should be mentioned the following:

1. *Methods in which the tube is made from the anterior gastric wall:* a. Depage<sup>44</sup> method: It was described in 1901. A quadrangular flap is made from the anterior gastric wall with the free end close to the lesser curvature. The edges of the lips of the flap are sutured to each other forming a tube the base of which is

close to the greater curvature and the opening in the stomach is closed.

b. Janeway<sup>45, 46</sup> method, suggested in 1913: The flap in this method has its free end close to the greater curvature and when the tube is made, its base lies close to the lesser curvature; in other words, the opening leading into the stomach is above the fluid level and for this reason leakage is less frequent than in the previous method.

c. Hirsh<sup>47</sup> method: He suggested a method in 1911 in which the flap has its free end close to the pylorus running from the lesser to the greater curvature. In this method the blood supply going to the flap is cut from both sources, from the blood vessels of the lesser and of the greater curvature.

2. Methods in which the tube is made from the anterior and posterior gastric walls. a. Beck-Carrel<sup>48</sup> method, suggested in 1905: The tube is made from a narrow quadrangular flap, the long sides of which are produced by cutting the anterior and the posterior gastric walls parallel to the greater curvature and the free end by cutting the connecting distal points of the two previous lines. The flap is turned orally and a tube is formed. The opening leading into the stomach is closed. The tube is brought in front of the chest wall and used as the lower portion of a prethoracic esophagus. Later, some surgeons attached this tube to the abdominal wall and used this tube for gastrostomy purposes. The same method was suggested by Jianu, in 1912, and it is known by many by this name. However, the priority belongs to Beck-Carrel.

b. Partsch<sup>49</sup> method, suggested in 1935: The tube is formed from both curvatures from a flap which is a reversed Beck-Carrel flap.

*V. Tubovalvular Methods.* These are characterized by forming a tube from a gastric flap and a valve at its base. The tube is lined with mucosa and does not obliterate; the valve closes the base of the tube thus making the stomach water

tight. Attempts to make the stomach water tight were made by surgeons from the time of inception of gastrostomy. It is an interesting fact that in many different methods the surgeons who offered their devices called them valves, valvular mechanisms, and in some cases employed the word sphincter, using it interchangeably with the word valve. Sédillot in his description of a metallic cannula, consisting of two parts called each of the components parts "a valve." Witzel in describing his method in 1891 in which the channel runs obliquely compares it with the course of the ureter and claims that the stomach is water-tight due to its "valvular-action." E. Andrews and E. Wyllys Andrews in describing their method analyze the Witzel's operation and say: "the Witzel fistula thus formed resembled the ureter where it enters the bladder, and being valvular prevented leakage." In presenting their own method in which they formed an intramural gastric channel lined with mucosa they say about this channel "the valve of the stomach was in good working order and readily pervious to tubes." In other words they claim that their valve is patent. Stamm describing his method asserts that when he draws the ends of the purse-string together it forms "a double sphincter" and later he refers to the same structure as "two sets of valves." Here we have an example of a surgeon using the term sphincter and valve interchangeably.

Senn described his method in 1896 under the title "Gastrostomy by a Circular Valve Method." He says: "An incision about one-half inch in length made in the apex of the exposed cone. A rubber tube is inserted through this opening into the stomach and pushed down, so that the stomach wall is now inverted, forming a circular valve."

Fontan describing his method in 1896 states that he formed "a channel resembling the hollow of a bishop's mitre, thus constituting the valve." Here we see that he calls by the word "valve" what we usually designate as a "channel."

a. *Spivack's tubovalvular method:* Spivack<sup>50</sup> utilized a portion of the anterior gastric wall to form a tube and the adjoining portion to form a valve (a cork, buttress). This valve consists of the entire thickness of the gastric wall which is doubled (Fig. 9), so that it is surrounded everywhere by mucosa. *It differs from all other methods in which doubling of the wall took place (as in Witzel's, Kader, Stamm, Fontan) in this respect that in his method the doubled wall forming the valve is left intact and is placed at the base of a tubular canal and serves as a real buttress, whereas in all above mentioned methods the surgeon transformed this doubled wall into a channel, thereby reducing the valve to a mere fold of mucosa.* In all their methods they relied upon watertightness being achieved by the compressing ability of the gastric muscle, excess of the mucosal fold and tortuosity of the channel, while Spivack relies entirely on the power of the valve closing the tube hermetically. In Spivack's method it can be demonstrated on dogs, that after the tubovalvular stomach is made, it can be removed *in toto*, filled with water until it becomes a distended balloon, turned with the tube down and not a drop leaks out from the stomach, whereas in no other method this can be achieved.

We had many occasions to witness the holding power of the valve. In several cases the patients, having the tubovalvular gastrostomy, vomited through the constricted esophagus, ejecting the food, introduced through the gastrostomy opening, without a single drop leaking through the gastric stoma. This observation which Spivack made on his very first case of gastrostomy is mentioned by Lowry and Sorenson, and was observed several times by other surgeons. In several cases the tube sloughed off and still not a single drop leaked from the stomach.

#### TECHNIC

*Step 1. Abdominal Incision.* While any kind of abdominal incision can be made, we prefer to open the abdomen by a left

mid-rectus longitudinal incision four inches long starting immediately below the left costal arch.

constructed from the upper two-fifths of the flap, thus making the opening close to the greater curvature (Fig. 5); however, in

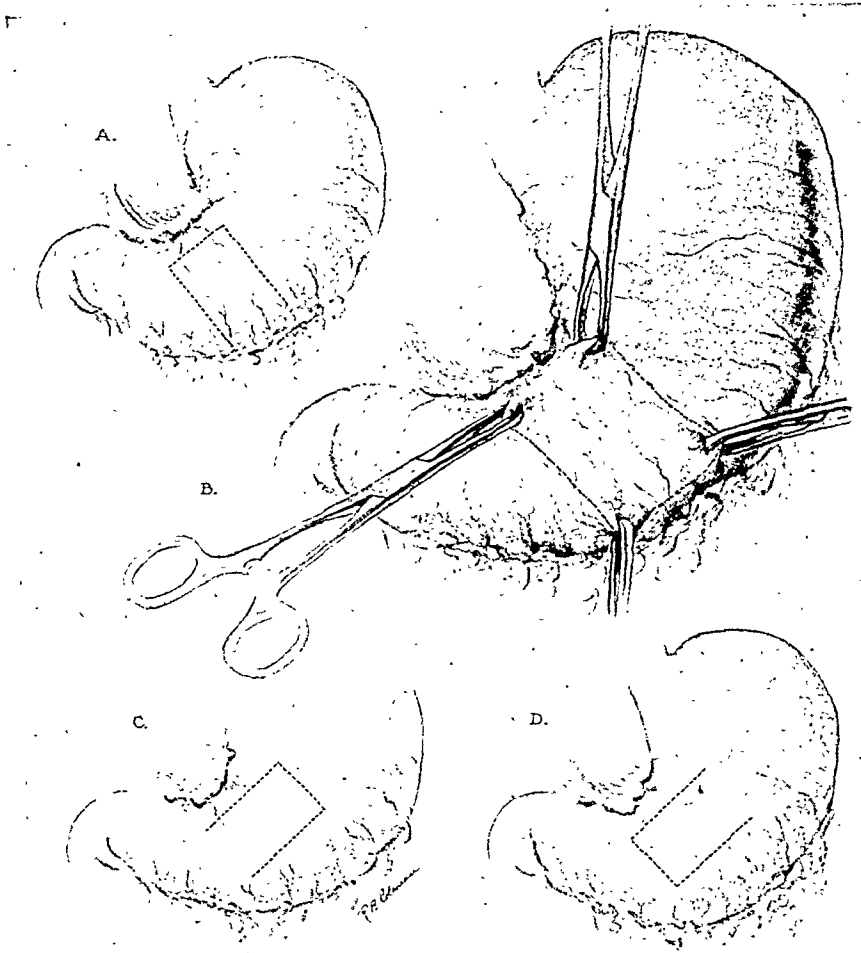


FIG. 4. Spivack's method of gastrostomy. A, Depage flap; B, Janeway flap; C, Hirsch flap; D, reversed Hirsch flap.

*Step 2. Selection of Flap.* A portion of the anterior gastric wall close to the fundus is delivered outside. A quadrangular flap, three inches long and two inches wide, is outlined and each corner of it is grasped by Allis forceps. (Fig. 4.) If the stomach is small, the size of the flap may be made considerably smaller, however, the ratio of 3:2 (height to width) should be preserved. That the gastrostomy flap may be considerably smaller is attested by the fact that several surgeons, including the originator, made it on infants, children and on the small bowel.

*Step 3. Formation of the Valve.* This is

some cases the valve may be made from the lower two-fifths of the flap.

a. A seromuscular bite is taken at a point of the line connecting the upper and the lower angles of the outlined flap at a distance of two-fifths of this line from the upper angle. Another seromuscular bite is taken through the upper angle of the same line. Each end of the thread is clamped by a small forceps. (Fig. 5A.)

b. Another suture is placed at symmetrical points along the vertical line connecting the upper and lower angles of the other side of the outlined flap. (Fig. 5A.)

c. A forceps is placed behind these threads and their ends are tied to each other. (Fig. 2B.)

Step 4. Formation of the Tube. a. A



FIG. 5. Spivack's method of gastrostomy. A, B and C, different stages of doubling the anterior gastric wall to form a valve.

d. A seromuscular suture unites the two opposite ridges starting from the end farthest from the operator. (Fig. 5B.) Care should be taken in doing so to suture the ridges at symmetrical places and not to encroach upon the lower portion of the flap. (The author saw few cases in which the surgeon doing this step started correctly at one end and while suturing the opposite ridges reached the lower corner of the opposite side thus leaving no flap

seromuscular vertical incision starting from the right upper angle is made up to the right lower angle; another seromuscular incision parallel to the first is made from the left upper to the left lower angle; a transverse seromuscular incision connecting the lower angles is made. Small blood vessels are seen traversing the mucosa; they are ligated doubly and cut between the ligatures, thus reducing bleeding to a minimum. Occasionally, we ligate the ves-

sels singly; then by cutting the mucosa, there is some bleeding from the flap, which serves as an indication that the blood supply to the flap is sufficient. (Fig. 6A.)

technical point of view this can be done by starting to close the stomach from below; or it can be done by starting the suturing from the upper angles of the flap

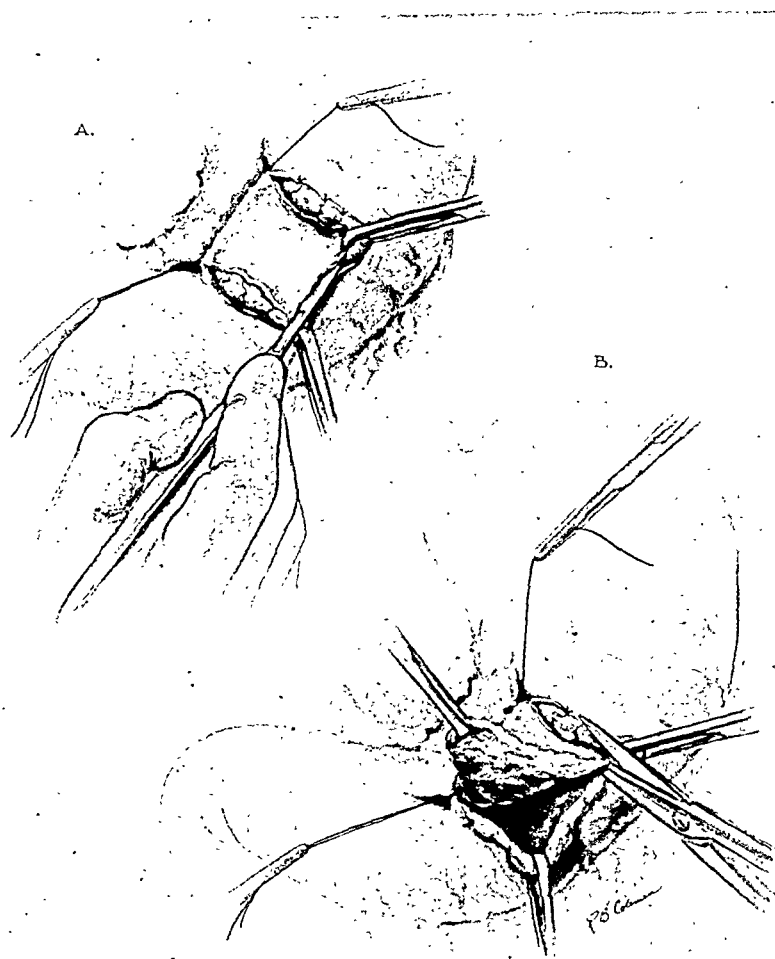


FIG. 6. Spivack's tubovalvular gastrostomy. A. seromuscular incision; B, the stomach is opened.

b. The mucosa is cut along the three lines. The produced flap is reflected upward. (Fig. 6B.) At the base of this flap lies the valve, which was constructed in the previous step. It is seen that the mucosa of the valve forms a dome, the apex of which reaches nearly to half of the height of the flap, the future tube. (Fig. 7A.) When the flap will be transformed into a tube by the subsequent steps, this valve will hermetically shut off the lumen of the stomach from that of the tube.

c. Suturing the flap into a tube. From a

downwards, until the entire opening is closed. We prefer to do it in the following way: A bite is taken through each upper corner of the flap; another thread takes a bite through each lower angle of the flap immediately above the point where the seromuscular suture was inserted in Step 3. (Fig. 7A.) The ends of the upper thread are tied to each other; the same is done with the ends of the lower thread. Thus a tube is formed, the upper and lower ends of which are already sutured. (Fig. 7B.) The ends of seromuscular suture inserted in

Step 3 and left long until this moment are now cut short. Next, the opening into the stomach is closed, starting from the lower end by a continuous through-and-through

have it away from the lips of the tube while these lips are sutured, after the completion of which the forceps is removed.

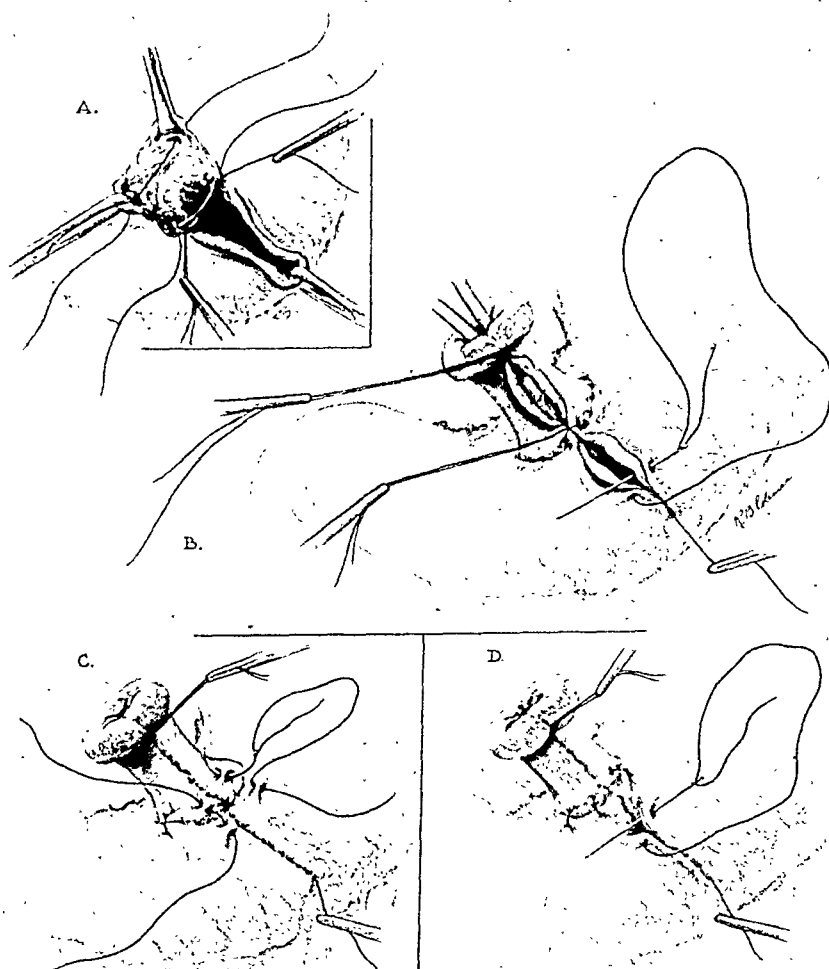


FIG. 7. Spivack's tubovalvular gastrostomy. A, the valve is seen at the base of the flap; B, suturing the flap into a tube and closure of the gastric opening; C, reinforcing the weak spot at the base of the tube; D, second row of seromuscular sutures.

suture. This suture is continued in an upward direction in order to complete the suturing of the tube, the upper and lower ends of which had been sutured already. (Fig. 7c.)

As the valve is very powerful and may even protrude outside the lips of the tube, it is easy to include it with the suture while suturing the lips to each other, which certainly should be avoided because it will occlude the tube. Therefore, it is advisable to place a forceps into the lumen of the tube compressing the valve so as to

As the point where the base of the tube joins the stomach at the suture line is a potentially weak spot, from which leakage may ensue, it is advisable to reinforce it. This we accomplish by invaginating the base of the tube into the adjoining gastric wall by placing three seromuscular sutures, one bite of which goes through the stomach at a distance of one-fourth of an inch from the base of the tube and the other bite at the wall of the tube at a height of one-eighth of an inch from the base of the tube. This expedient not only reinforces the

"weak spot" but may also aid in compressing the wall of the tube against the valve, thus enhancing the water-tightness

stomach above the tube and close to its base, next through the peritoneum and the posterior sheath of the rectus muscle of

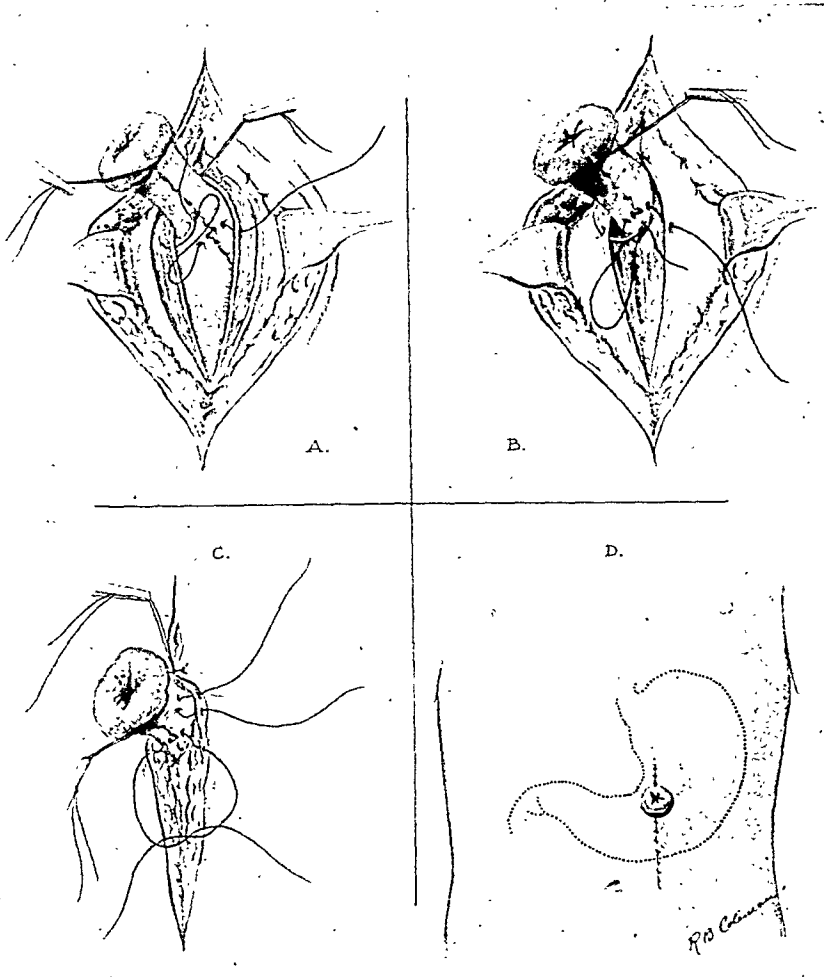


FIG. 8. Spivack's tubovalvular gastrostomy. A, fixation of the stomach to the parietal peritoneum; B, fixation of the tube to the anterior sheath; C, fixation of the tube to the skin by a subcuticular suture; D, the external opening of the tube.

of the stomach. (Fig. 7C.) When the first row of sutures is completed, another sero-muscular line of sutures is inserted, also starting from below and reaching the upper end of the tube. (Fig. 7D.)

*Step 5. Fixation of the Stomach and the Tube to the Anterior Abdominal Wall.* a. The anterior wall of the stomach is sutured to the parietal peritoneum and the posterior sheath of the rectus muscle by taking a bite through the posterior sheath and the peritoneum of one lip of the abdomen, then through the seromuscular layer of the

the other lip, when the ends are tied. The same is done to suture the peritoneum and posterior sheath of the rectus muscle of one lip of the abdominal wall, then through the seromuscular layer of the stomach *below* the tube and then through the other lip, when the ends are tied. Before tying the ends of the thread, care should be taken to see that the tube is not constricted. (Fig. 8A.) Thus, two objectives are attained: The stomach is attached to the anterior abdominal wall only at two points and not by a broad surface, and the



tube comes to lie extraperitoneally. The latter feature permits the removal of the tube under local analgesia when the temporary stoma is no longer needed.

the seromuscular layer in the form of a rosette; in this way the serosal layer of the tube does not come in contact with the air, which would cause it to become dry, the

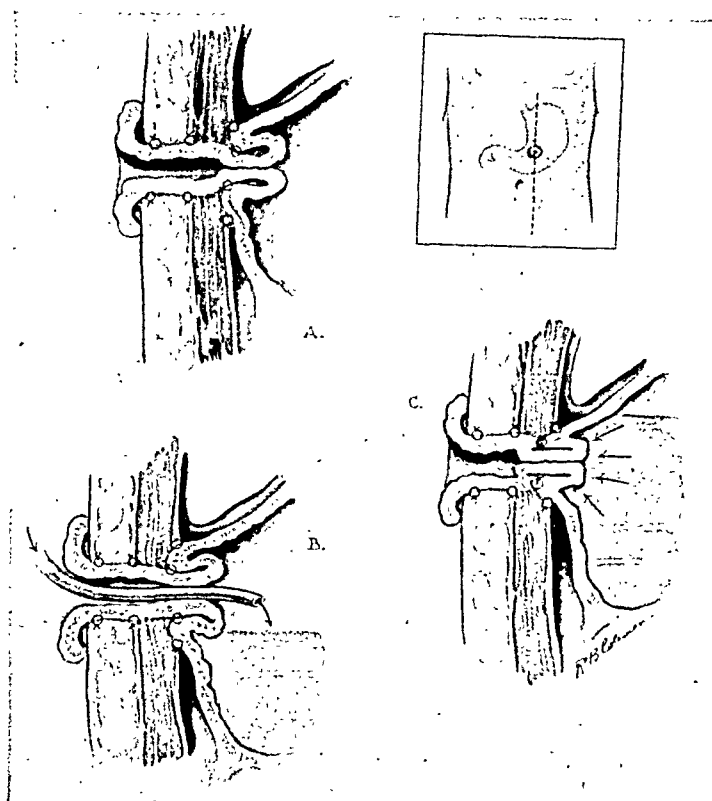


FIG. 9. Spivack's tubovalvular gastrostomy. A, cross-section, showing the valve in its natural position; B, cross-section, showing separation of the valve by the catheter; C, cross-section showing propulsion of the valve into the base of the tube by intragastric pressure, thus occluding hermetically the stomach.

b. The tube is attached to the anterior sheath in two places. (Fig. 8b.)

c. The tube is attached to the skin by four sutures at four points of the tube at a distance of one-fourth of an inch from its free end. One point is at the anterior wall of the tube, the other at the posterior and the third and the fourth at each lateral side. The anterior and the posterior points are sutured to both lips exactly the same as the tube is sutured to the anterior sheath, each lateral point of the tube being sutured only to its adjoining cutaneous lip. (Fig. 8c.) We intentionally leave about one-fourth of an inch of the tube above the skin, to allow for its future retraction. The mucosa of the tube covers

slight secretion from the mucosa of the rosette being just enough to withstand the dryness of the air, but not sufficient to flow upon the skin and irritate it. We do not suture the mucosa to the skin as is commonly done by many surgeons the reason for it being that a stitch taken through the mucosa is contaminated and this is one of the most frequent causes of infection of the abdominal wall.

The tubovalvular method can be performed on a very small stomach. In such cases one does not need to outline a flap of 3 by 2 inches; it may be considerably smaller. However, the ratio of 3 to 2 (the height to the width) should be preserved. This operation was performed several

times on newborn infants (McNealy<sup>51</sup>) and small children (E. M. Miller<sup>52</sup>). This tubovalvular operation was performed by the

of anterior and from the posterior gastric wall. (Fig. 10.)

The abdomen is opened and a portion



FIG. 10. Spivack's tubovalvular gastrostomy for a small and contracted stomach. A, utilization of the anterior portion of the posterior gastric wall to form the tube and the valve; B, formation of the valve; C, beginning the formation of the tube; D, the tube is made and the rent in the stomach is closed; closure of the gastrocolic ligament.

originator<sup>53</sup> on the jejunum, colon and urinary bladder.

If the stomach is very small and if one still wishes to have a fairly good sized valve and a tube, one can resort to a modification of this method devised and used by Spivack since 1931 and published<sup>54</sup> in 1933. It consists of utilizing not only the anterior but also the posterior gastric wall, forming the valve from the anterior gastric and the tube from the lower portion

of the stomach is delivered outside the abdominal cavity; the quadrangular flap is outlined as for the usual type of tubovalvular gastrostomy, with this sole difference that the ratio of height to width is 3:4 (in other words, the height is  $1\frac{1}{2}$  inches and the width 2 inches). Four Allis forceps are placed, one at each corner of the flap; the valve is now formed from the entire flap as described in Step 3 of the tubovalvular gastrostomy. The gastro-

colic ligament is cut for a width equal to that of the flap; the gastro-epiploic arteries are divided between two ligatures at each angle of the flap. The posterior wall of the stomach is now drawn anteriorly for a distance of one inch and a half, thus forming a quadrangular area, the width of which is two inches and the height one and one-half inches. This posterior wall is cut at its base and sides, thus forming a flap, the edges of which are sutured to each other to form a tube, after which the opening leading into the stomach is closed. The edges of the divided gastrocolic ligament are sutured to each other, thus restoring the normal relation of the stomach to the colon.

This particular modification of his original method Spivack demonstrated many times in his classes since 1931 and on March, 1932 had an occasion to perform it on a patient of Dr. G. Thompson, former President of the Chicago Surgical Society who assisted him in the presence of W. A. N. Dorland, the distinguished gynecologist and world renowned lexicologist. This method was published<sup>54</sup> in April, 1933.

The tubovalvular gastrostomy is now employed by a great number of surgeons in the United States and abroad. Several articles were written on this method in this country and abroad: Lowry and Sorenson,<sup>55</sup> Wing,<sup>56</sup> G. M. Blech,<sup>57</sup> D. Wagner<sup>58</sup> Baher and Frehling,<sup>59</sup> all in the United States, Prof. Linberg,<sup>60</sup> of Moscow, Bosh Arana,<sup>61</sup> of Buenos Aires, de Freitas,<sup>62</sup> of Sao Paulo, hailed this method as the operation of choice and honored the originator by naming the operation for him. Many of them not only called attention to the merit of the method but also to its originality.

In 1934, Toprover,<sup>63,64</sup> of Leningrad, described a method which became very popular in Russia. He was influenced by Spivack's method of tubovalvular gastrostomy. He considered Spivack's idea of a combination of a valve and of a tube a good one, but the technic was complicated,

and he thought that he could produce a tubovalvular apparatus in a simpler way.

His technic is as follows: After the abdomen is opened a portion of the anterior gastric wall close to the cardia is drawn outside in the form of a cone. The apex of the cone is held by two guy-sutures placed at a distance of 1 to 2 cm. from each other. Three purse-string sutures are then placed on the cone: the first one at a distance of 2 cm. from the apex, the other at 1½ cm. farther away from the first, and the third at the same distance from the second one. Next the apex of the cone is opened and into its lumen is inserted a rubber tube with a 1 cm. diameter. Then each purse-string suture is tied around the tube and the rubber tube is removed. Thus the cone is transformed into a 4 cm. long tube with three valves; this tube is fixed to the parietal peritoneum at four places by inserting a seromuscular suture between the second and the third row of the purse-string sutures, depending on the thickness of the abdominal wall. The mouth of the tube is sutured to the skin also at four places by carrying four interrupted sutures through the entire thickness of the wall of the tube and through the skin. In his earlier technic he made an invaginating fold at the base of the tube around its entire circumference, thus forming a valve "as Spivack does it." However, later he discontinued this particular step.

This method has been employed to a considerable extent in U.S.S.R. so that a number of facts were accumulated which enables one to evaluate its merits. Toprover considers Spivack's method of making a valve and a tube ingenious, features which have to be preserved. However, while he simplified the technic he lost in this process some very important features. One important factor of Spivack's method is the constancy of the size of the valve and of the tube after they are made; another is the definite ratio in the size of the valve to the diameter of the tube. This constant ratio is possible only when the diameter of the tube and the width of the valve remain

unchanged. If for some reason after the apparatus is built the valve shrinks or the tube becomes wider, there will be a relative insufficiency of the valve and the apparatus loses its watertightness.

In Toprover's method three sutures form the tube and the valves. If the thread or threads cut through, the tube becomes a cone and the valves disappear. Thus the water-tightness is lost and the method of gastrostomy instead of being one of the latest becomes one of the oldest. That this occurs in Toprover's method is shown in reports by several investigators, such as Suetina,<sup>65</sup> Prof. Zabłudovsky,<sup>66</sup> B. A. Petrov,<sup>67</sup> and V. A. Vorobiov.<sup>68</sup> There is another technical problem in Toprover's method, namely, how tight the purse-string should be drawn. If too tight, there may arise necrosis of the tube; if loose, the valve will not be large enough and the stomach will not be water-tight. Suetina made a study of sixty-two patients operated upon by the Toprover method in the clinic of Prof. Nazarov; in this number the stomach was watertight in fifty-seven patients (92 per cent) while they were in the clinic; in five cases water-tightness was lost while they were still in the clinic, suppuration of the wound took place and the sutures "cut through" with resulting transformation of the tube into a cone and disappearance of the valves.

It is interesting to note that in Spivack's method of gastrostomy suppuration took place in several cases so that the entire tube sloughed away, but the valve held. Of thirty-three patients who were discharged from Nazarov's clinic (twenty-nine died while in the clinic) it was possible to follow up twenty-eight patients. Of these seventeen retained the water-tightness as long as they lived (three lived while the report was published and fourteen died. The longest time any patient lived after the operation was seven months and twenty days).

Spivack was able to observe a patient who lived twenty-six months after Spi-

vack's gastrostomy and whose stomach remained water-tight.

In summarizing Toprover's method, Dr. Suetina finds three faults: (1) In order to make the tube, one has to have a surface at least 8 to 10 cm. in diameter. (2) There is no criterion how tight the purse-string should be drawn; if done insufficiently, there will be leakage; if too tight, necrosis of the cone will ensue; (3) In case of "cutting through" of the sutures into the lumen of the stomach, the water-tightness is lost.

Toprover,<sup>69</sup> in defending his method, claims that "cutting through" of the threads is the result of improper technic. However, this is not the case. It is a well known fact that ligation of a tubular viscus, be it the pylorus or a Fallopian tube, may be followed in a few weeks or in a few months by the lumen becoming patent. Therefore, this "cutting through" of the sutures is not to be blamed upon technic but represents an intrinsic feature of the method. However, in Spivack's gastrostomy the *diameter of the tube remains constant*. The size of the valve is also less liable to changes, because it is not a circular one; no constant pressure is exerted on it as in Toprover's or any other type of circular valve method, for which reason "cutting through" of the suture with the loss of valve action does not take place. For all these reasons it is evident that Toprover's method is not a further development of Spivack's method but a step backward.

Instead of employing a catheter to render the stomach water-tight many attempts were made to use some metallic devices. As a matter of fact, in the first two operations on a human being done by Sédillot, a cannula was introduced into the stomach. It was soon discarded on account of leakage between the gastric lips and the cannula. This leakage is not due to a faulty construction of the metallic device. It is attributable to the principle itself, because in order to be water-tight the metal tube has to fit snugly against the

lips of the stomach and when it does, necrosis of the tissue takes place, the cannula becomes loose and leakage results.

In recent years there were again several attempts to reintroduce metal instruments. Buliginsky,<sup>70</sup> in 1926, and Liubishkin,<sup>71</sup> in 1931, used an aluminum spool, Lubarsky,<sup>72</sup> in 1928, a silver spool. Dragstedt et al.<sup>73</sup> used a brass tube or cannula plated with gold. However, these methods have the inherent defect mentioned above and for this reason are not used often.

#### REFERENCES

1. MOEHLAU, F. G. Gastrostomy in the seventeenth century. *Buffalo M. J.*, 35: 395-397, 1895-1896.
2. COVILLARD, J. Observations iatro-chirurgiques avec Notes de Thomassin. Strassbourg, 1791.
3. EGBERG, CHR. A. Om Behandlingen af impenetrable Stricturer i Mædrøret. Published by Prof. Johan Hjort. *Norsk mag. f. lægevidensk.*, 2: 97, 1841.
4. BASSOW. *Bull. Soc. impériale des Naturalistes de Moscou*, 16: 315, 1843.
5. BLONDLOT. *Traité analytique de la digestion*. P. 201, 1843.
6. SÉDILLOT, C. Operation de gastro-stomie, pratiquée pour la première fois le 13 Novembre 1849. *Gaz. méd. de Strassbourg*, 9: 566-578, 1849.
7. COCHU. Observation de gastrostomie. *Gaz. d. Hôp.*, 26: 160-161, 1853.
8. FENGER, E. Ueber Anlegung einer künstlichen Magenöffnung am Menschen durch Gastrostomie. *Arch. f. path. Anat. u. Physiol.*, 6: 350-384, 1854.
9. FORSTER, J. COOPER. Description of the operation of gastrotomy. *Guy's Hosp. Rep.*, 4: 13-18, 1858.
10. SCHARFFENBERG. *Gastrotomiae propter oesophagi stenosis institutae historia*. Dissert. Kiel, 1867 (Description of Van Thaden operation).
11. MAURY, F. F. Case of stricture of the esophagus in which gastrostomy was performed. *Am. J. Med. Sc.*, 59: 365-371, 1870.
12. SKLIFASSOFSKI, M. W. Gastrostomy. *Medizinski Vestnik*, 19: 165 and 173, 1879.
13. JONES, SYDNEY. Gastrostomy for stricture (cancerous) of esophagus; death from bronchitis forty days after operation. *Lancet*, 1: 678, 1875.
14. VERNEUIL. Observation de gastro-stomie pratiquée avec succès pour un rétrécissement cicatriciel infranchissable de l'oesophage. *Bull. Acad. de méd.*, 5: 1023-1038, 1876.
15. SCHOENBORN. Ueber Gastrostomie. *Arch. f. klin. Chir.*, 22: 500-518, 1878.
16. TREDELENBURG, F. Ueber einen Fall der Gastrostomie bei Oesophagusstrictur. *Arch. f. klin. Chir.*, 22: 227-234, 1878.
17. VON HACKER, V. Ueber die Verwendung des Musculus rectus abdominis zum Verschlusse der künstlichen Magenfistel. *Wien. med. Wchnschr.*, 36: 1073-1078 and 1110-1114, 1886.
18. TROUP, F. Case of gastrostomy. *Edinburgh M. J.*, 18: 36-37, 1872.
19. GIRARD. Neue Methode der Gastrostomie mit Sphinkterbildung. *Korr. Bl. f. Schweiz. Aerzte*, 18: 345, 1888.
20. HAHN, E. Eine neue Methode der Gastrostomie. *Zentralbl. f. Chir.*, 17: 193-195, 1890.
21. VINOKUROV, I. J. Proceeding of the Odessa Medical Society of September 15, 1890. (describing Ssabanejev's method) *Vratch.*, no. 39, 1890.
22. SSABANEJEV, I. F. On making a tubular gastric fistula in strictures of esophagus. *Chir. Vestnik*, 9: 690-700, 1893.
23. JABOULAY. Procédé pour pratiquer la gastrostomie et la cystostomie. *Gaz. hebdomadaire méd. chir.*, 31: 89-90, 1894.
24. LUCY, R. H. The after-treatment of cases of gastrostomy. *Edinburgh M. J.*, 5: 46-50, 1899.
25. FRANK, RUDOLPH. Eine neue Methode der Gastrostomie bei Carcinoma Oesophagi. *Wien. klin. Wchnschr.*, 6: 231-234, 1893.
26. HARTMAN, H. Note à propos d'un cas de gastrostomie. *Gaz. hebdomadaire méd. chir.*, 2: 157-158, 1897.
27. ULLMANN, E. Zur Technik der Gastrostomie. *Wien. med. Wchnschr.*, 44: 1662-1663, 1894.
28. SCHWARTZ, E. Gastrostomie par la procédé de la torsion de Souligoux. *Bull. et mém. Soc. de chir. de Paris*, 28: 815-819, 1902.
29. SOULIGOUX, CH. Gastrostomie par torsion. *Bull. et mém. Soc. de chir. de Paris*, 37: 818, 1911.
30. ALBRECHT. Ueber die Torsion des vorgezogenen Magenstückes. Inaug. Diss. Greifswald, 1895.
31. WITZEL, O. Zur Technik der Magenfistelanlegung. *Zentralbl. f. Chir.*, 18: 601-604, 1891.
32. GERNEZ, M. L. Sur la gastrostomie permanente. *Bull. et mém. Soc. Nationale de chir.*, 55: 1107-1110, 1929.
33. GERNEZ, M. L. et HO-DAC-DI. Nouvelle technique de gastrostomie. *Presse méd.*, 38: 191-192, 1930.
34. STAMM, M. Gastrostomy by a new method. *Med. News*, 65: 324-326, 1894.
35. FONTAN. Une nouvelle operation de gastrostomie (Procédé valvulaire) *Assoc. franç. de chir. Dixième Congres de Chirurgie. Proc.-verb. etc. Paris*, 10: 411-415, 1896.
36. FONTAN. Sur une nouvelle opération de gastrostomie. *Semaine méd.*, 16: 423, 1896.
37. KADER, B. Zur Technik der Gastrostomie. *Zentralbl. f. Chir.*, 23: 665-670, 1896.
38. ANDREWS, E. and ANDREWS, E. WYLLIS. A new method of valvular gastrostomy with a mucous membrane lining. *J. A. M. A.*, 22: 734-737, 1894.
39. MARWEDEL, G. Zur Technik der Gastrostomie. *Brunns' Beitr. z. klin. Chir.*, 17: 56-74, 1896.
40. SCHNITZLER, J. Zur Technik der Gastrostomie. *Wien. klin. Rundschau*, 10: 513-514, 1896.
41. FISCHER, F. Mittheilung über Magenfistelbildung. *Verhandl. der deutsche Gesells. f. Chir.*, 24: 229-239, 1895.
42. SORESI, A. L. Intramural gastrostomy. *Am. J. Surg.*, 36: 668-671, 1937.
43. TAVEL, E. Eine neue Methode der Gastrostomie. *Zentralbl. f. Chir.*, 33: 634-635, 1906.
44. DEPAGE, A. Nouveau procédé pour la gastrostomie. *J. de chir. et ann. Soc. belge de chir.*, 1: 715-718, 1901.

45. JANEWAY, H. M. The relation of gastrostomy to inoperable carcinoma of the esophagus. *J. A. M. A.*, 61: 93-95, 1913.
46. JANEWAY, H. M. Eine neu Gastrostomiemethode. *München med. Wchnschr.*, 60: 1705-1707, 1913.
47. HIRSCH, M. Plastischer Ersatz des Oesophagus aus dem Magen. *Zentralbl. f. Chir.*, 38: 1561-1564, 1911.
48. BECK, CARL and CARRELL, ALEXIS. Demonstration of specimens illustrating a method of formation of a prethoracic esophagus. *Illinois M. J.*, pp. 463-464, May, 1905.
49. PARTSCH, F. Zur Indikation und Technik der Magenfistel. *Zentralbl. f. Chir.*, 62: 1449-1454, 1935.
50. SPIVACK, J. L. Eine neue Methode der Gastrostomie. *Brun's Beitr. z. klin. Chir.*, 147: 308-318, 1929.
51. MCNEALY, R. W. Personal communication, 1932.
52. MILLER, E. M. and BOTHE, R. T. Spontaneous stricture in a young child followed by spontaneous opening one year after tubovalvular gastrostomy. *Surgery*, 6: 598-601, 1939.
53. SPIVACK, J. L. The Surgical Technic of Abdominal Operations. 1st. ed., p. 248, 1936; 2d ed., 190-191, 1938. Chicago, S. B. Debour.
54. SPIVACK, J. L. Utilization of the posterior wall of the stomach in valvulo-tubular gastrostomy in case of small and contracted stomach. *Clin. Med. & Surg.*, 40: 212-213, 1933.
55. LOWRY, NELSON H. and SORENSON, S. Spivack's method of gastrostomy. *Am. J. Surg.*, 18: 521-528, 1932.
56. WING, H. J. A new method in gastrostomy. *Clin. Med. & Surg.*, 39: 101-104, 1932.
57. BLECH, G. Book Review of "Surgery of the Stomach and Duodenum" by J. S. Horsley. *Military Surgeon*, 74: 167, 1934.
58. WAGNER, DAVID. Spivack's gastrostomy. *Ann. Surg.*, 107: 1005-1021, 1937.
59. BAHER, FRANK H. and FREHLING, STANLEY. The Spivack gastrostomy. *New England J. Med.*, 219: 305-309, 1938.
60. LINBERG, Spivack's gastrostomy. Festival Volume in Honor of Prof. Hesse. *Vestnik kbir.*, 1933. (Quoted from Toprover.)
61. ARANA, BOSH. Personal communication.
62. DE FREITAS, J. M. Gastrostomia tubo-valvular de Spivack. *Rev. de cir. de São Paulo*, 6: 309-314, 1941.
63. TOPROVER, G. S. Novy Sposob Gastrostomii (A new method of Gastrostomy). *Vestnik kbir.*, 34: 23-30, 1934.
64. TOPROVER, G. S. Eine neue Methode der Gastrostomie. *Zentralbl. f. Chir.*, 61: 1919-1921, 1934.
65. SUETINA, M. P. Gastrostomii po Toproveru. *Vestnik kbir.*, 56: 75-79, 1938.
66. ZABLUDOVSKY, A. M. Gastrostomia po Toproveru. *Vestnik kbir.*, 56: 71-74, 1938.
67. PETROV, B. A. Gastrostomia po Toproveru. *Vestnik kbir.*, 56: 80-85, 1938.
68. VOROBIOV, V. A. Raziedanie koji pri gastrostomii po Toproveru. *Vestnik kbir.*, 59: 644-645, 1940.
69. TOPROVER, G. S. Dangers, errors, and unforeseen complications of gastrostomy by my method. *Vestnik kbir.*, 51: 102-106, 1937.
70. BULIGINSKY, G. N. Technic of gastrostomy. *Vestnik kbir.*, 21: 132, 1926.
71. LIUBISHKIN, I. A. Aluminum tube in gastrostomy. *Vestnik kbir.*, 23: 106, 1931.
72. LUBARSKY, B. Beitrag zur Technic der Gastrostomie. *Zentralbl. f. Chir.*, 55: 3151-3154, 1928.
73. DRAGSTEDT, L. R., HAYMOND, E. H. and ELLIS, JAMES E. Cannula gastrostomy and enterostomy. *Surg., Gynec. & Obst.*, 56: 799-801, 1933.



# EARLY EXTIRPATION OF THE UTERUS IN PERSISTENT ATONY WITH POSTPARTUM HEMORRHAGE\*

HARRIS M. RABINOWITZ, M.D.

Attending in Gynecology and Obstetrics, Beth-El Hospital

AND

NATHAN REIBSTEIN, M.D.

Associate in Gynecology and Obstetrics, Beth-El Hospital

BROOKLYN, NEW YORK

**P**OSTPARTUM hemorrhage is a most perilous complication of childbirth.

A most hazardous obstetrical tragedy, it has assumed the leadership in the triumvirate of hemorrhage, sepsis and toxemia as the cause of maternal death. While sepsis and toxemia have shown a very favorable decline during the last few years, hemorrhage has been less kind and has taken a very heavy toll postpartum. Plass<sup>1</sup> states that hemorrhage and shock is the leading cause of maternal mortality.

A report of the U. S. Bureau of Vital Statistics shows that death from postpartum hemorrhage averaged 16 per cent of all the puerperal deaths from 1931 to 1940; that 2,048 women died of postpartum hemorrhage in 1940, a considerable rise to 23 per cent. We believe that with the decline of sepsis and toxemia under improved care, hemorrhage with its many non-preventable phases has, therefore, the percentage ascendancy as a cause of maternal puerperal deaths.

Gordon,<sup>2</sup> in a study of vital statistics, shows that hemorrhage is assuming the leading rôle as a cause of obstetrical maternal death. He found that in Brooklyn, thirty-one women died of hemorrhage in 1937, twenty-nine in 1938, sixteen in 1939, twenty-eight in 1940, and twenty-three in 1941, a total of 127 women dying of hemorrhage during this period. He stresses thoughtless management of the third stage of labor, anesthesia and insufficient blood replacement as the responsible and contributing factors.

The prolonged postponement of active interference in postpartum bleeding too

often leads to these tragic deaths, when earlier intervention could have saved many a life. It is with this view in mind that we wish to bring out an idea, which though by no means new, bears repetition and further stressing.

In the acute and very severe cases of postpartum hemorrhage with lack of contractility of the uterine wall, hysterectomy following delivery has been recommended and practised by some (Bland,<sup>3</sup> Hunt<sup>4</sup>) but not sufficiently stressed. In the mild or less severe cases conservatism is advised by all.

Who knows, or who can foretell, where the line of demarcation between these two types is located? The attendant has tried all the accepted orthodox methods of controlling hemorrhage by the administration of oxytocic drugs, uterine massage, uterine and vaginal packing and repacking; the replacement of blood loss with saline, glucose, plasma and whole blood,—all these measures failing to control the persistent bleeding. Should he stand by and permit the patient to develop the dreaded picture of shock and irreversible shock? How long should he wait before actively interfering by removing the offending organ through a hysterectomy and thus save a life? How often by procrastinating has he lost the period of grace, when it has become too late to perform this life saving procedure?

Blalock<sup>5</sup> says that there is no satisfactory treatment for the hematogenic type of shock that has persisted for several hours and that the treatment is more successful in the early stages of its develop-

\* From the Department of Obstetrics and Gynecology, Beth-El Hospital, Brooklyn, N. Y. Read before the Brooklyn Gynecological Society, October 6, 1944.

ment. It is his opinion, which is confirmed by the work of Haldane,<sup>6</sup> that the length of time that the patient lives with an inadequate supply of blood and oxygen to the tissues determines the alterations that are to be found in them. It is evident that slow death produces greater alterations in the tissues than sudden death. Where can this be more true than in the prolonged bleeding postpartum?

Schumann<sup>7</sup> observes that the patient with a violent onset of bleeding usually recovers. It is in those patients in whom the greatest dangers lie, where the bleeding is moderate, a continuous trickling of blood from the uterus, when mild measures are depended upon to stop the bleeding until the anemia becomes acute with shock supervening and sudden death before any active treatment is instituted.

Beecham,<sup>8</sup> in an analysis of fifty-two cases of deaths from postpartum hemorrhage, found that rarely was there any voluminous bleeding but rather a steady, moderate flow of several hours' duration, ending in shock and death. He found that the average time between delivery and death was five hours. Only six patients died within two hours and none died when the elapsed time was less than one and one-half hours. Of these cases, seven were abruptio and six inertia uteri. Eight patients went into shock and died without any apparent attempt at treatment. He concludes that in absence of lacerations of cervix or vagina as a cause of the bleeding, hysterectomy is indicated.

Bland<sup>9</sup> recommends hysterectomy following delivery, when there is acute or severe postpartum hemorrhage and lack of uterine contractility.

DeLee<sup>9</sup> states that in abruptio placenta, with a concealed type of hemorrhage, with the abdomen very hard and the uterus tender, cesarean section is indicated; if the uterus is found hemorrhagic, a Porro section is indicated. Again, DeLee<sup>10</sup> states that if the woman shows hemophilic tendencies during her pregnancy or after delivery extirpate the uterus; if hemo-

pathia appears postpartum and other measures failed to contract the uterus, hysterectomy should be done.

Miller<sup>11</sup> states that when performing a cesarean section for abruptio, if the uterus fails to contract promptly after the extraction of the child, immediate hysterectomy should be done.

Greenhill<sup>12</sup> comments that in abruptio, when bleeding is profuse and persists, a cesarean section is indicated and in some cases the uterus has to be sacrificed.

Rauramo and Kahanpaa,<sup>13</sup> in a study of 163 cases of women with uteroplacental apoplexy, show that in ninety-four patients treated conservatively there were five deaths, while in sixty-nine patients treated surgically only one died. It is the opinion of these authors that uteroplacental apoplexy is due to vascular changes in the uterus and yet they are not in favor of extirpation, saying that the indication is rare, and the existing hematomas in the uterus disappear rapidly. They stress the importance of early diagnosis. Where is their line of demarcation?

Hunt<sup>4</sup> reviewed 344 cases of true obstetrical hemorrhage: fifty cases of placenta previa, thirty-five cases of abruptio placenta, 227 cases of postpartum bleeding and thirty-two miscellaneous cases. He performed four hysterectomies in this series: two for rupture of the uterus, one for abruptio and one for complicating fibroids. Subsequent to this report he extirpated the uterus once for abruptio and once for uncontrollable bleeding in placenta previa. All patients survived. He decries the fact that the rôle of hysterectomy as a procedure has been neglected. Seldom is hemorrhage so severe or intractable as to require it, yet because of this very fact women often die because the procedure is delayed, when this was their only chance for survival. With cervical and vaginal trauma excluded as causative factors, after vigorous massage, adequate packing and repacking failing to control the bleeding, hysterectomy is indicated at once.



Gustafson<sup>14</sup> states that severe abruptio placenta occasionally demands section followed by hysterectomy, which latter may be the most conservative obstetric procedure in certain situations.

Stander<sup>15</sup> states that when cesarean section is performed for premature separation of the placenta, hysterectomy should be done in those cases which show marked disintegration of the uterine musculature.

In a review of our cases of postpartum hemorrhage from 1937 to 1944, we found a total of thirty-seven cases of very severe bleeding. Of these only three patients survived. These latter patients were hysterectomized early.

The following seven cases, the details of which will be presented, illustrate the importance of early hysterectomy. The first two patients, representative of conservative therapy in this series, died.

CASE I. B. K., age twenty-nine, gravida 2, para 1, had a normal first pregnancy and delivery. Her last menstrual period began May 10, 1941. The prenatal course was uneventful. She was admitted February 12, 1942, at 4 P.M.; pains occurred every five minutes; the position was R.O.A., there were fetal heart sounds in R.L.Q., the cervix was dilated  $1\frac{1}{4}$  cm., the head presenting at minus 2 station; the membranes were ruptured. She delivered spontaneously and forcibly at 8 P.M. of a stillborn male child; she expelled the placenta five minutes later. Pituitrin was administered, as per routine. The uterus became relaxed with marked bleeding. The cervix and vagina were found intact. The uterus was packed and a blood transfusion given. The patient died three hours later. On postmortem examination a Couvelaire uterus was found.

CASE II. K. K., age twenty-eight, gravida 2, para 1, said her last menstrual period began December 20, 1936. She was admitted October 15, 1937, at 4:30 A.M., being about two weeks overdue. Pains occurred every five minutes. Fetal heart sounds were heard above the umbilicus, breech presenting; the membranes were ruptured. At 5:15 A.M. she had a convulsion, controlled by M.S. gr.  $\frac{1}{2}$ . At 6 A.M., she delivered spontaneously a stillborn female baby, weighing five pounds. The placenta was expelled five minutes later. At 6:20 A.M. there

was a moderate uterine hemorrhage. The usual therapy was instituted and parts were inspected. The uterus was packed. She expired at 8:45 A.M., two hours and twenty minutes after the initial hemorrhage. Sections of the placenta showed areas of degeneration.

The following two patients were operated on after some delay and they died.

CASE III. F. W., age twenty-four, gravida 2, para 0, was admitted April 24, 1937, at 9:30 P.M. She had moderate vaginal bleeding, with severe uterine contractions every two minutes. There was no cervical dilatation and fetal heart sounds were not heard. Ablatio placenta was diagnosed and a cesarean section was performed at 12 midnight. The uterus was found to have several small areas of bluish infiltration into its wall. After completion of the section, the patient began to bleed profusely from the vagina. The usual treatment together with whole blood transfusion was ineffectual. At 1:30 A.M. the uterus was extirpated. She died at 8 A.M. of shock. Sections of the uterus showed extensive uterine apoplexy.

CASE IV. F. N., age thirty-nine, gravida 9, para 6, stated her last menstrual period began January 10, 1942. Her prenatal course was uneventful, except for persistent headaches. All laboratory tests were negative. Her highest blood pressure was 128/80. She was admitted October 10, 1942, at 9:15 A.M. Pains occurred every fifteen minutes; the position was L.O.A., the cervix was dilated  $1\frac{1}{4}$  cm., and membranes were intact. At 1:30 P.M. she began to bleed moderately, a bright red blood. She was examined in the delivery room at 2:30 P.M. and the cervix was found dilated  $8\frac{1}{2}$  cm. No fetal heart sounds were heard and the abdominal wall had a board-like rigidity. A No. 6 Voorhees bag was inserted into the uterus and the vagina tightly packed with iodoform gauze. Glucose, 10 per cent solution in saline was given intravenously, followed by 500 cc. of citrated blood. At 4:30 P.M. the vaginal pack and bag were expelled, with bulging membranes presenting, which were ruptured with an instrument, soon to be followed by a spontaneous delivery of a stillborn baby and placenta; 1 cc. pituitrin and 1 cc. ergotrate were given subcutaneously. There was no vaginal bleeding. The condition of the patient appeared good and she was transferred to her bed. At 5 P.M. she began to bleed; oxytocics were administered and the uterus massaged

and packed. She bled through the pack. She was taken to the operating room, given a transfusion and repacked, without control of

postpartum bleeding. (A total of 3,000 cc of blood was given.) Pathological report: uterine apoplexy.



FIG. 1.

FIG. 2.

FIG. 1. Topographic view of myometrial hemorrhages. (Specimen taken from patient who died.)

FIG. 2. Topographic view of hemorrhages into broad ligament. (Specimen taken from a patient who died.)

the bleeding, with evidence of shock presenting. At 6:45 P.M. a supracervical hysterectomy was performed, her condition being fair immediately after operation. At 8 P.M. she seemed to appear much better than prior to operation. At 11 P.M. her condition became worse. Transfusion and all measures to combat shock proved ineffectual. She expired at 12:40 A.M., about seven and one-half hours after the initial

The next three patients recovered after early hysterectomy:

CASE V. E. G., age forty-three, gravida 8, para 7, stated that her last menstrual period was in June, 1942. She was admitted at 7:15 A.M., March 1, 1943, her blood pressure having risen to 166/120, with urine showing 4 plus albumin. A medical induction of labor was decided upon. She was given castor oil and then

10 mg. of stilbestrol every-four hours for four doses without effect. The next day her pressure rose to 178/120, with no change in urinary

weighing four pounds, at 10:15 A.M. The placenta followed immediately. At 2:30 P.M. the uterus relaxed and began to bleed. Ergo-

FIG. 3.

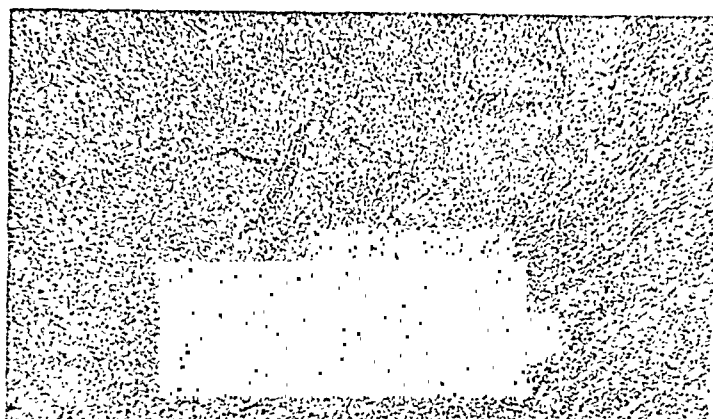


FIG. 4.

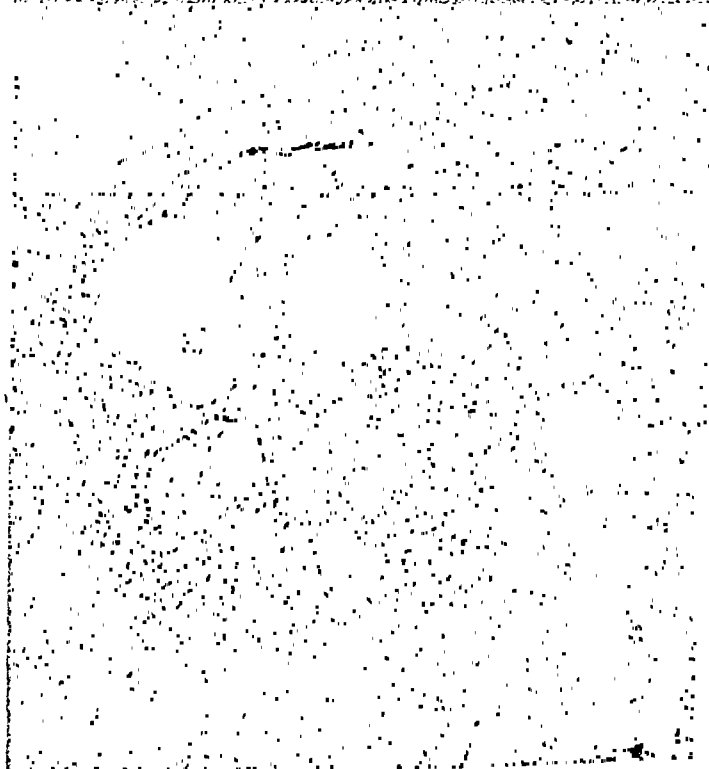


FIG. 3. Topographic view of myometrial hemorrhages; note massive character of hemorrhagic infiltrates. (Specimen taken from a patient who died.)

FIG. 4. Topographic view of hemorrhages into ovarian stroma. Note massive character of hemorrhagic infiltrates and tendency toward perivascular accentuation. (Specimen taken from a patient who recovered.)

findings. Blood chemistry showed urea 30 mg. per cent and uric acid 10 mg. per cent. A catheter was introduced into the uterus and the vagina tightly packed. The catheter and pack were removed at 6 A.M. the following morning. She was delivered of a living baby,

trate was given intravenously and the uterus was massaged. Glucose, 5 per cent solution in saline was started intravenously, followed by 500 cc. of plasma. The bleeding was uncontrolled and the patient was going into shock. One hour later, under ether anesthesia, with

transfusion given simultaneously, hysterectomy was performed. The patient made an uneventful recovery and was discharged at the end of fourteen days. Pathological report: extensive uterine apoplexy.

CASE VI. M. F., age twenty-nine, gravida 3, para 2, whose gestation lasted seven and one-half months; was admitted at 10 A.M., July 7, 1944, because of vaginal bleeding. The abdomen was distended and tender; fetal heart sounds were not heard. The cervix was dilated  $1\frac{1}{2}$  cm., with the head presenting at minus 2 station; the membranes were ruptured. A tight abdominal binder was applied and a blood transfusion started. One-half hour later the vaginal bleeding was profuse. At 1:50 P.M., a cesarean section was performed, followed by a supracervical hysterectomy. A stillborn baby, weighing four pounds was delivered. Convalescence was somewhat stormy. She was discharged at the end of sixteen days. Pathological report: Extensive uterine apoplexy.

CASE VII. E. S., age twenty-eight, gravida 3, para 2, stated that her last menstrual period began September 13, 1942. Her prenatal course was uneventful. She was admitted at 10 A.M., June 9, 1943. Pains were strong and occurred every three minutes; position was L.O.A.; the fetal heart was heard in L.L.Q., the cervix was dilated  $7\frac{1}{2}$  cm., the head presenting at zero station. She delivered spontaneously one hour later, a living baby, weighing six pounds. The placenta was expelled five minutes later, followed by a large gush of blood. Ergotrate was given intravenously. The cervix and vagina were found intact. The uterus remained relaxed after intrauterine packing and massage. Glucose in saline was given intravenously, followed by 250 cc. of plasma. The patient rallied, bleeding stopped and the uterus was firmly contracted. Two hours later the uterus became relaxed and bleeding resumed. The patient was given a blood transfusion and a hysterectomy was performed under ether anesthesia. Her blood pressure at the time of operation was zero. Blood was given through two veins at one time. The postoperative course showed a fluctuating temperature, with an elevation from 101 to 102.4°F. She was discharged at the end of two weeks. Pathological report: uterine apoplexy, involving the entire right side of the uterus and extending into the broad ligament.

In a study of the pathological findings in the cases reported, we note an extensive

extravasation of blood into the uterine musculature, between muscle bundles and individual muscle fibers (Figs. 1 and 3); also involving the adnexa (Figs. 2 and 4), and extending into the parametrium, the pathological picture of uteroplacental apoplexy, or Couvelaire uterus. The pathological findings in the uteri of the recovered cases show as much, and in some patients even more extensive involvement (Figs. 3 and 4) than in those who failed to survive.

These cases definitely emphasize the fact that not the extent of the involvement alone is the determining factor in the success or failure of therapy but rather that the time element plays a very significant rôle. Cases V, VI and VII show that when the bleeding is uncontrollable, no time should be lost to extirpate the uterus, as is evidenced by these women recovering as a result of undelayed treatment. Cases III and IV show that hesitancy and delay in removing the uterus was responsible for their mortality, while Cases I and II are examples of the ineptness of conservative therapy in severe and uncontrollable bleeding from the postpartum uterus.

It is our opinion, therefore, that when confronted with non-traumatic, uncontrolled bleeding postpartum, with the uterus failing to contract, the presence of uteroplacental apoplexy should be immediately considered, regardless of the presence or absence of classic signs or symptoms. Since there is no definite method of predetermining or evaluating the extent of the uterine involvement, hemorrhage should be our only guide. When uterine hemorrhage cannot be controlled postpartum, one hour should be the deadline for conservatism, after which extirpation of the uterus should be resorted to at once.

#### REFERENCES

1. PLASS, E. D. *West. J. Surg.*, 42: 396-401, 1942.
2. GORDON, CHARLES A. *Am. J. Obst. & Gynec.*, 46: 366-373, 1943.
3. BLAND, P. B. *Am. J. Obst. & Gynec.*, 36: 165-172, 1938.

4. HUNT, ARTHUR B. *Minnesota Med.*, 26: 355-362, 1943.
5. BLALOCK, ALFRED. *Principles of Surgical Care, Shock, etc.* P. 144. St. Louis. 1940. The C. V. Mosby Co.
6. HALDANE, J. S. *Brit. M. J.*, 2: 65, 1919.
7. SCHUMANN, E. A. *New York State J. Med.*, 39: 2178-82, 1939.
8. BEECHAM, CLAYTON T. *Am. J. Obst. & Gynec.*, 37: 258-264, 1939.
9. DELEE, JOSEPH B. *Year Book of Obstetrics & Gynecology*. P. 230, Chicago, 1928.
10. DELEE, JOSEPH B. *Year Book of Obstetrics & Gynecology*. P. 230, Chicago, 1941.
11. MILLER, C. J. *New Orleans M. & S. J.*, pp. 637-642. April, 1928.
12. GREENHILL, J. P. *Year Book of Obstetrics & Gynecology*. P. 258, Chicago, 1942.
13. RAURAMO, M. and KAHANPAA, V. *Acta obst. et gynec. Scandinar.*, 20: 243-292, 1940.
14. GUSTAFSON, G. W. *Am. J. Obst. & Gynec.*, 43: 221-231, 1942.
15. STANDER, H. J. *Am. J. Obst. & Gynec.*, 44: 531-541, 1942.



Expectant treatment for an ectopic pregnancy at any stage and in any location is highly hazardous, as the sac may rupture without a moment's warning and the patient might die from the ensuing hemorrhage.

From "The Management of Obstetric Difficulties" by Paul Titus (C. V. Mosby Company).

# A WORKING BASIS FOR THE TREATMENT OF HEAD INJURIES

THEODORE L. HYDE, M.D.

Chief of Surgical Section, The Dalles Clinic

THE DALLES, OREGON

THE treatment of head injuries is a responsibility of the general surgeon. Although general surgeons usually refer neurosurgery patients to neurosurgeons possessing the special technical facilities and skill, head injuries are emergencies demanding immediate attention and which tolerate transportation poorly. The distribution of neurosurgeons in this country is not wide enough but what most conscientious general surgeons prepare themselves to carry the responsibility of the treatment of head injuries.<sup>1</sup> In the past this responsibility has not seemed superficially to be too difficult because without fully realizing it most doctors belonged to the "do-nothing" school of thought. Acrimonious controversy and honest difference of opinion among neurosurgeons as to proper procedure fostered this attitude of hopelessness. Many years ago the operation of indiscriminate sub-temporal decompression was shown to be followed by disappointing results. This engendered an argumentative extreme of ultra-conservatism amounting almost to nihilism regarding operative treatment. This attitude was welcomed with an unconscious sigh of relief by doctors who were embarrassed by the responsibility of making the decision to operate as well as by the performance of the operation.

There are still many things to be learned about head injuries but the progress made in recent years has been sufficient to provide a working basis for the treatment of head injury cases. This very definitely includes surgical intervention for certain complications and with positive indications. The disagreements among the authorities in the face of which the ordinary

surgeon felt quite at sea are more apparent than real. The appearance of confusion is due at least in part to the fact that neurosurgeons are sometimes very positive and even contentious individuals. Actually there is considerable agreement upon the basic features of the treatment and the conscientious application of the newer knowledge has produced demonstrable improvement in the results.<sup>2</sup>

## THE UNCONSCIOUS PATIENT

When first seen by the surgeon the patient with a head injury is a problem in unconsciousness. Although the history of an accident may be definite and the wound on the head may be obvious, the unconsciousness in truth may have preceded and caused the fall or other accident and a brief consideration by the surgeon of the classic problem of unconsciousness is in order. Azotemia, diabetic acidosis, hyperinsulinism, spontaneous cerebrovascular accidents, and poisoning are usually easily recognized if the surgeon thinks to look for them, although the help of the laboratory may be required. Alcoholism seems especially common among head injury cases and it is sometimes difficult to estimate its relative importance. Most "dead-drunk" individuals can be roused by firm pressure over the supra-orbital notch. When several diagnostic possibilities present themselves the immediate therapy should be for the most serious of them. Fortunately the ordinary treatment for shock is beneficial for most of the causes of unconsciousness. No alcoholic patient has ever been unduly imposed upon for being given the consideration due to a serious head injury.

Unconsciousness from head injury carries about a 5 per cent mortality. An approximate additional 10 per cent is carried progressively by each of the following factors: laceration of the scalp, fracture of the skull, especially depressed or compound, laceration of the dura, involvement of the frontal or ethmoid sinuses, laceration of the brain, and penetration to the cerebral ventricles. These mortality rates can be improved by proper surgical care.

#### SHOCK

Strictly speaking traumatic shock in the sense of a progressive hemoconcentration, etc., is not a particularly common result of head injury. When present it is often the result of concomitant injuries to other parts of the body. Occasionally the head injury is so gross as to cause shock just as will a mangled foot or other large destruction of tissue. Death from head injury is more commonly a failure by direct affection of vital nerve centers. Such distinctions are perhaps more academic than real, however, because if shock is present or if the patient's progress indicates it is imminent, the treatment should be instituted. A single small dose of morphine may be very beneficial and is permissible immediately after the injury. Later morphine is to be avoided as diagnostically confusing when a decision to operate is pending. If the circulatory failure of shock is present and there is no active bleeding from head lacerations, the head may be lowered, although here again later the situation may be reversed and the head better elevated. One hundred per cent oxygen by inhalation is especially valuable for brain damage. However, we shall not attempt to describe the details of the treatment of shock.

#### CONCOMITANT INJURIES AND FRACTURES

An unconscious human with a head injury deserves a surgeon who is as good as a veterinarian: since the patient cannot talk the doctor must examine him and find his other injuries. External hemor-

rhage and shock take precedence of course over all other considerations. The tendency is to minimize and temporize with whatever other injuries the patient may have. Extensive débridements, general anesthetics, and in fact anything more than first aid dressings may truly be contraindicated. There should be no compromise with the principle of immobilization of fractures, however, and for this purpose nothing less than plaster of paris is acceptable. There is an old adage to the effect that splints are all right for most patients but plaster casts are necessary for children, psychopaths, athletes and doctors. Head injury patients are included among the psychopaths and in anticipation of the severe restlessness to come and to minimize shock, plaster immobilization should be included in any first aid measures for the other injuries. The application of a plaster cast need be no more shocking than any other dressing or splint.

#### ROENTGEN DIAGNOSIS

In years past the tendency was to rush the patient immediately to the x-ray department to see if there was a skull fracture, often at the expense of proper shock therapy. Now the pendulum has swung to the other extreme and the x-ray examination may be unduly delayed. Sometimes a roentgenogram shows a fracture line crossing the middle meningeal artery or a venous sinus and is an early clue to an intracranial hemorrhage which will be fatal if not promptly relieved surgically. A properly conducted x-ray examination need not add to the shock and probably is best made after the first shock therapy has produced satisfactory improvement. An unconscious patient is more cooperative for the examination than a delirious restless one. The x-ray examination is not a very satisfactory proposition at best since many skull fractures are not shown. We have seen a fracture line which showed in only one of a pair of stereoscopic films. Since the base of the skull is the more fragile part many fracture lines extend

through the base although the vault is more exposed to direct fracturing trauma. Fractures of the base are more difficult to demonstrate by the x-ray and cannot be excluded by a negative roentgenogram, especially if clinical evidence is present such as bleeding from the nose, ears, into the orbit, drainage of cerebrospinal fluid, or cranial nerve injuries. Positive evidence of skull fracture is important, negative evidence less so.

A proper x-ray examination for fracture of the skull requires nine plates: stereoscopic views taken with each side and both ends of the skull next to the plate and an additional anteroposterior view taken at 35 degrees toward the vertex with the chin on the sternum to show the foramen magnum region. The anteroposterior stereoscopic view should be taken from an angle of 25 degrees toward the vertex with the shift of the tube toward the vertex. The postero-anterior view likewise should be at a 20 degree angle with the shift toward the vertex. The lateral views should center 2 cm. up and 2 cm. back from the external auditory meatus with the shift toward the vertex. These views give the impression of looking down into the base of the skull.<sup>3</sup> There should be no reluctance about taking additional plates at other angles to show suspicious areas.

#### CONCUSSION

Concussion is a heretofore vague term which has been given more exact meaning recently with demonstration of the effect upon the brain of acceleration or deceleration of about the magnitude of 28 feet per second.<sup>4</sup> This is about 19 miles per hour or about seven-eighths of the acceleration of a freely falling body. If a moving head strikes an immovable object, the speed may be reduced to zero in less than one second and the initial speed need not be so great. Force may be applied to the head in such a way as to induce sufficient rotational acceleration of the peripherally situated brain cells with less energy than would be required for a straight line

acceleration. This explains the efficacy of a blow by a boxer on the chin tangential to the center of inertia which may induce concussion by rotating the head whereas the same force or blow applied squarely to the side of the head would be below the critical rate and ineffective. The intimate molecular structure of the individual nerve cells of the brain is affected. Apparently the lipoid of the brain cells is accumulated into microscopically visible fat droplets.<sup>5</sup> Under these circumstances all nervous activity of the cell ceases. The process is sometimes quickly reversible else no prize-fighter would rise before the count of ten or even thereafter. Some concussion changes are not reversible as evidenced by the punch drunk state of veteran prize-fighters although it is difficult in any given case to exclude the occurrence of more gross changes such as petechial hemorrhage, etc. Severe and irreversible concussion changes may be fatal as evidenced by death occurring from head injury without grossly demonstrable brain change. The degree of concussion is an established element at the instant of injury and so far no means of influencing it directly have been discovered. Supportive shock therapy of a general nature is all the surgeon has to offer. Clinically, the situation is complicated by the practical fact that extreme degrees of prolonged concussion are almost invariably associated with contusion, laceration, or hemorrhage.

#### CONTUSION, LACERATION AND HEMORRHAGE

The brain is a semi-liquid mass enclosed within a rigid shell but just as the yolk of an egg can be broken without injuring the shell so can the brain be structurally contused within the brain case. Any severe concussion is usually the result of forces which momentarily alter the shape of the brain cavity either within or outside the limits of its elasticity (fracture). These alterations in shape and fluid movements of the brain are associated with contusion of the brain substance amounting often to laceration and hemorrhage from torn



blood vessels. A particular center of stress and movement is directly opposite the point of application of the force (contrecoup<sup>6</sup>) where hemorrhage is frequently found.

In addition to the obvious lacerations from foreign bodies, laceration of the brain and of blood vessels is often produced by the edges of bone fragments of depressed fractures. The structure of the vault of the skull with its two hard tables separated by the softer cancellous diploe is such that localized fracturing force usually produces several jagged fragments of the inner table which are driven in and pierce the dura and brain substance. This damage to the brain is the significant and important aspect of depressed skull fractures and not the deformity of the bone.

#### INCREASED INTRACRANIAL PRESSURE

Contused brain tissue swells less than, but essentially the same as, a smashed finger or a sprained ankle. The increase in the volume of the brain of this traumatic edema takes place within the strict confines of the rigid brain case at the expense of the volume of the circulating blood. Deficient circulation causes anoxia which in turn produces more edema and thus a vicious cycle is established. Hemorrhage of any considerable volume likewise displaces circulating blood. The swelling of traumatic inflammatory edema can be influenced by so-called medical measures. Systemically this is a matter of dehydration and is simply a process of reducing the intake to where the fluid available for urinary excretion is less than a liter per twenty-four hours. How much less is a matter of clinical judgment and the whole organism must be considered rather than just the injured head. There are definite systemic limitations to dehydration and moreover there is very little evidence that it can be pushed to any extreme degree sufficient to influence the local demands for fluid of an area of contused tissue. Dehydration by the use of saline cathartics is unnecessary and to be avoided.

The swollen brain has been observed to shrink after the intravenous injection of concentrated glucose solution. The duration of this shrinkage is probably a few hours at best and may be followed by even more severe swelling. Solutions of disaccharides seem to have a more lasting effect. Sucrose is sometimes very injurious to the kidneys;<sup>7</sup> Sorbital solution may be less so. Preliminary studies<sup>8</sup> and theoretical considerations indicate that colloid solutions of concentrated serum albumin or plasma have many advantages over any crystalline solutions for shrinkage and are expected to replace the latter entirely.

#### LUMBAR PUNCTURE DRAINAGE

Brain injury may be followed by an increase in the production and total volume of cerebrospinal fluid. Whether this is so or not, room within the skull for edema and hemorrhage can be obtained by removing some cerebrospinal fluid. A diagnostic examination of the spinal fluid and determination of its pressure are indicated in any injury severe enough to produce unconsciousness. There may be some danger in removing spinal fluid after head injury but the risk must be very small and is amply justified by the positive benefits. High pressure if the dynamics are normal is the best evidence of swelling and hemorrhage.

The pressure should be measured by a manometer; the rate of flow from a spinal needle is no indication of the pressure. A spinal fluid manometer can be easily improvised from a piece of small-bore glass tubing with a short piece of rubber tubing to serve as adaptor and elbow. Any blood pressure apparatus can also be adapted to measure spinal fluid pressure.

The diagnostic tap should not be made too soon as an early negative examination may fail to show blood which has not had time to diffuse into the lumbar region, or high pressure which may only develop after a few hours. If the pressure is high some fluid should be removed slowly, allowing it to drip out through the needle.

The amount to be removed is about twice that necessary to return the pressure to normal, up to a maximum of 75 cc. The rapid removal of too much fluid in normal animals may be followed by rapid replacement of the fluid and sometimes a shock-like reaction, but such an untoward sequel can be avoided by the slow removal of only the indicated amount. Probably less than half of head injury cases ever show an increased intracranial fluid pressure requiring specific therapy by drainage.

There has been great and unfortunate controversy over the question of lumbar drainage versus intravenous hypertonic solutions with dehydration. Because the latter can also reduce the increased intracranial pressure some enthusiasts have insisted upon their being used exclusively. If the diagnostic spinal tap shows an increased intracranial pressure, some fluid should be removed and in a few hours some concentrated plasma or albumin given intravenously. If the clinical condition suggests persistence or recurrence of increased pressure, another tap should be done both for diagnosis and therapy. Rapid recurrent or late increase in pressure to a high level is very suggestive of intracranial hemorrhage of some sort. Dehydration measures are supplementary to spinal tap and not a substitute.<sup>9</sup> They may reduce localized edema in a beneficial way that removal of spinal fluid cannot accomplish. Both methods should be used and repeated as indicated by the clinical condition of the patient.<sup>10</sup>

#### THE HEAD WOUND

After shock and external hemorrhage have been controlled and the other injuries dressed and immobilized, if the response has been satisfactory, x-rays are taken. Then if a scalp laceration or a compound fracture of the skull is present definitive treatment should be instituted. A compound skull fracture deserves the same considered emergency treatment as any other compound fracture. Under local anesthesia the head can be operated upon

without producing shock to an extent that compound fractures of the extremities cannot be.<sup>11</sup> Moreover infection is more serious and it is more important to proceed as soon as possible to make the débridement, etc., within the so-called critical six-hour interval.<sup>12</sup> If necessary, intravenous therapy for shock can be continued while the patient is on the operating table. Immediate access to a vein should always be available during any intracranial operation so that restlessness and convulsions can be controlled by intravenous barbiturate and an already running intravenous infusion provides this nicely.

Operations on the head are no more difficult than elsewhere. Visibility and exposure are usually gratifyingly simple. Hemorrhage is more of a problem and it may require more patience to hold a muscle stamp over a bleeder for five minutes than to clamp and tie the vessel but it is really no more difficult. Bone wax and suction are essential accessories and a diathermic coagulating element is very desirable. Fine cotton is the preferable suture material.<sup>26</sup> If no prepared head rest is available, a bandage-rolled "doughnut" of absorbent cotton serves very well. The scalp should be shaved widely. Ephinephrine may be added to the anesthetic solution.

A minimum of skin is excised and all dirt and small loose bone fragments are removed. Compound depressed fractures are elevated. Large fragments of bone can sometimes be replaced in such a way as to close defects partially. Subdural bleeding is explored if evident beneath intact dura. Foreign body lacerations or penetration tracts in the brain are gently débrided by suction.<sup>13</sup> Foreign bodies are removed only if easily found.<sup>14</sup> Lacerated dura is sutured with fine cotton sutures, and closed snugly if possible. Drainage is instituted only if the frontal or ethmoidal sinuses are entered. Sulfanilamide (never sulfathiazole<sup>15</sup>) may be frosted over the surface of the wound if there has been gross contamination or undue delay. After operation systematic sulfa drugs should be given

to a significant blood level as prophylaxis against meningitis and brain abscess.<sup>16</sup> Undercutting and "s"-type extensions of the lacerations will usually produce enough relaxation to close wounds with even considerable loss of tissue. The scalp will tolerate a surprising amount of tension if sutured evenly. A continuous skin stitch accomplishes this best although it may not give as fine a scar. Non-compounded depressed skull fractures are not necessarily an emergency by themselves although probably should be explored and elevated eventually. Foreign bodies should be sought later only if they cause definite trouble.

#### INDICATIONS FOR EXPLORATORY CRANIOTOMY

The patient with a head injury may become a surgical emergency at any hour and is a serious problem in observation. The blood pressure, pulse, respiration, temperature, and state of activity are recorded every half hour or oftener if there is any notable change. There seems to exist considerable confusion regarding the purpose of such observation. We have seen clinical records which were very accurate and detailed accounts of the patient's progress to death. That the clinical picture contained all the indications for craniotomy which could have been life saving was entirely missed. Observations of the clinical condition of the patient and his improvement or relapse are important only as used for indications for treatment.

Edema and hemorrhage within a close container (the skull) create a mechanical problem of increased pressure for which mechanical relief can be provided. If dehydration and spinal fluid drainage are not adequate, operative therapy may have something to offer the patient. The clinical evidences of the swelling and hemorrhage have been roughly grouped together as "the signs of increased intracranial pressure." These with the addition of certain localizing signs of hemorrhage constitute, therefore, the indications for surgical intervention. As a matter of observed fact

the swelling takes several hours to develop and the progressive hemorrhage rarely can be identified and localized in the first few hours so emergency craniotomy is seldom indicated immediately after the injury.

The classic instance of surgical intervention is the syndrome of hemorrhage from the middle meningeal artery: a head injury, brief concussion unconsciousness, a lucid interval perhaps of several hours, then progressive headache, drowsy stupor, coma, a dilated pupil with contralateral flaccid paralysis and eventual death or else emergency operation and returning consciousness. Unfortunately, this typical picture indicating surgery is not common even in hemorrhage from the middle meningeal artery, and the extremes of its wide variation are not duly appreciated. The essential features are usually present however. As mentioned above at the instant of injury certain irreversible changes may be produced in the brain which progress to death. By contrast, if the patient improves at any time and then gets worse again, the assumption should be that the relapse is due to intracranial hemorrhage demanding surgical relief. The hemorrhage may be from the middle or other meningeal vessels, the venous sinuses or the vessels of the brain itself and may be situated in extradural, or intra-arachnoid spaces, or within the substance of the brain,<sup>17</sup> and also may be bilateral.

The initial unconsciousness of concussion may persist and merge into the enduring coma from hemorrhage and edema of concussion. The lucid interval may be merely a momentary improvement in the clinical condition of the patient detectable only by close observation of the course of the blood pressure, pulse, etc. The relapse may be only a gradual deepening of the coma and failure of vital functions. The eye and other localizing signs may be merely a diminution of reflexes or minor changes requiring careful observation to recognize. The relapse phase may occur in the second week or later and be due to an internal hydrocephalus or it may occur months

later and be due to chronic subdural hematoma.

Some of the earlier assumptions indicating increased intracranial pressure have not stood the test of time. In spite of a normal pressure maintained by repeated taps and intravenous solutions the patient may proceed to death. The affection of the vital centers may be by direct pressure from localized edema and hemorrhage spreading from near-by areas of contusion. The often described slow pulse may or may not be associated with increased intracranial pressure and usually becomes quite rapid before death. Variations of rate from minute to minute are more significant and ominous. The systolic blood pressure may rise in the early stages and eventually fall as in shock so a fall to a low level following a rise is most significant. The diastolic blood pressure does not vary so much but a falling diastolic pressure is discouraging. Fever is significant especially if it rises to the extreme hyperpyrexia of heat center affection. The respiratory rate may get quite fast but early becomes Cheyne-Stokes in type and finally becomes absolutely irregular.

It is of great help in deciding to operate if localizing signs appear to indicate which side of the head may contain the hemorrhage. In fact it may be said that if there are clear indications as to where to make the incision that is all the surgeon needs. Paralysis of one arm or leg suggests a prerolandic cortical area hemorrhage. An early complete hemiplegia especially if the facial area is not involved is more apt to be associated with a basal lesion not so amenable to surgical relief. An intracranial hemorrhage often produces pressure on the oculomotor nerve. At first this may contract the pupil as an irritative phase which later is followed by paralysis and a widely dilated non-reactive pupil.<sup>18</sup> Concussion may be associated with transient conjugate deviation of the eyes and large sluggish pupils. Direct trauma to the oculomotor nerve at the moment of injury presents not only a dilated pupil but also ptosis of the

lid. Other peripheral cranial nerves are not so often involved by hemorrhage as by basal fractures. Eye fundal changes usually are too slow developing to be of help except for venous congestion in case of direct injury to the globe and optic nerve. Papilledema may appear as early as the third day but usually is delayed for a week.

#### EXPLORATORY CRANIOTOMY

Fortunately there is practically no shock and very little risk associated with an exploratory burr hole exposure of the dura. This is in sharp contradistinction to subtemporal decompression. If there is good reason for suspecting intracranial hemorrhage, a burr hole exploration should be made under local anesthesia. If the most likely side is negative, the other side should be explored promptly, too, as the paralysis may be on the same side as the hemorrhage.<sup>19</sup> The usual area of election is about two inches anterior and above the external auditory meatus. If no paralysis is present, a burr hole over the frontal area or over the occipital lobe may be preferable. The cranium can be explored for hemorrhage adequately through three burr holes on each side and all six can be made if necessary without significant shock. Seldom except perhaps immediately after the injury should a patient with head injury be allowed to die without the benefit of an exploration. Probably a fair proportion would be two or three negative explorations for each positive one. If a hemorrhage is found, a more extensive operation with better exposure may be necessary to control it.

#### AFTER-CARE

In addition to needing constant observation patients with head injuries are a serious problem in nursing care. The restlessness is often extreme and may cause additional injury. This restlessness is of two types: There is the absolute constant and total restlessness which is associated with injuries near the basal ganglia and is a very bad prognostic sign. There is also

the more common restlessness of delirium which is not so constant and is rather encouraging. This delirious restlessness is usually a response to stimuli of some sort and can be minimized by intelligent nursing care. The patient may be restless from pain or other injuries, or because of a full bladder, or because he is too hot, or his hands are restrained, or because he seems to be wearing a hat in the house (his bandage), etc. Padded side boards on the bed and constant sympathetic attention are the best types of restraint. Unless the clinical course is critical the judicious use of morphine may be justified. Seconal is a useful short acting sedative, too. An indwelling nasal stomach tube for feeding may be desirable if the patient does not "fight it." If the patient is not restless, he should be turned occasionally. Catheterization may be necessary to relieve a distended bladder. The bed should be kept dry and clean.

Prolonged bed rest has probably been overemphasized in the past. Recent evidence indicates that early ambulation is not only justified but beneficial.<sup>20</sup> Patients should be urged to be up and about as soon as they feel like it. This is especially desirable for its psychological effect. Patients with head injuries are prone to develop neuroses and accept their disability as an excuse from responsibility.<sup>21</sup> The injury and unconsciousness constitute severe psychic trauma following which a fearful attitude toward life is understandable, albeit undesirable. The patient's apprehensions are fostered by undue solicitude on the part of the surgeon. Earnest optimism and active encouragement of the patient by the surgeon are necessary.<sup>27</sup>

Contrary to popular opinion at least 80 per cent of patients with head injuries who survive should make a complete organic recovery. Residual defects of function from actual loss of brain substance do persist of course.<sup>22</sup> The human brain possesses remarkable ability to compensate for such lost functions over a period of months.<sup>23</sup> Late sequelae such as headache

and convulsions may appear months and even years later.<sup>24</sup> There is little evidence that a too sheltered convalescence lessens their incidence, however. Disabling headache as a sequel to head injury deserves investigation with pneumo-encephalograms, etc., to exclude chronic subdural hematoma.<sup>24</sup> Convulsions likewise require exact diagnosis and may be amenable to surgical relief, especially the approximate 50 per cent which are Jacksonian in type. Convulsions are prone to develop from scars from lacerations of the parietal cortex which heal without proper débridement of necrotic brain tissue.

#### CONCLUSIONS

1. Head injuries are emergencies and the general surgeon should be prepared to assume the responsibility of their treatment.
2. Although the problem is complex, sufficient knowledge is now available to provide a working basis for effective treatment and its application should produce a gratifying improvement in the results.
3. Plaster of paris casts should be used as first aid immobilization of concomitant fractures.
4. The x-ray examination should not be unduly delayed.
5. Increased intracranial pressure should be controlled by lumbar puncture drainage supplemented by intravenous hypertonic plasma or albumin solutions.
6. Scalp wounds should be given definitive treatment under local anesthesia promptly.
7. Relapse in the patient's condition after significant improvement should be assumed to be due to intracranial hemorrhage and is an indication for exploratory burr-hole craniotomy.
8. Early ambulation of patients with head injuries is preferable to prolonged bed rest.

#### REFERENCES

1. MERRITT, H. H. Head injury: review of the literature. *War Med.*, 4: 61-82, and concluded in 4: 187-215, 1943.

2. MOCK, H. E. and MOCK, H. E. JR. Management of skull fractures and brain injuries. *J. A. M. A.*, 120: 498, 1942.
3. EARL, DAVID H. Personal communication.
4. DENNY-BROWN, D. and RUSSELL, W. R. Experimental cerebral concussion. *Brain*, 64: 93, 1941.
5. DEGUTIERREZ-MAHONEY, W. Pathogenesis of traumatic unconsciousness. *War Med.*, 1: 816, 1941.
6. GOGGIO, A. F. The mechanism of contre-coup injury. *J. Neurol. & Psychiat.*, 4: 11, 1941.
7. ROWLETTE, A. P. and WEINER, D. O. Cranio-cerebral injury. *Surg., Gynec. & Obst.*, 72: 551, 1941.
8. TURNER, J. W. A. Concentrated serum in head injuries. *Lancet*, 2: 557, 1941.
9. WYCHGEL, J. M. and URBANSKI, W. J. Cranio-cerebral injuries. *Ohio State M. J.*, 37: 761, 1941.
10. PICKLES, W. Head injuries: study of 554 patients. *New England J. Med.*, 224: 139, 1941.
11. CARMODY, J. T. B. Management of major compound fractures of skull vault. *Am. J. Surg.*, 57: 389, 1942.
12. MUNRO, D. Bacteriology of wounds of compound fractures of skull. *New England J. Med.*, 227: 939, 1942.
13. CLOWARD, R. B. War injuries to the head. *J. A. M. A.*, 118: 267, 1942.
14. WALKER, A. E. Treatment of penetrating wounds of the head. *War Med.*, 2: 454, 1942.
15. PILCHER, C., ANGELUCCI, R. and MEACHAM, W. F. Convulsions produced by intracranial implantation of sulfathiazole. *J. A. M. A.*, 119: 927, 1942.
16. LINELL, E. A. and ROBINSON, W. L. Head injuries and meningitis. *J. Neurol. & Psychiat.*, 4: 23, 1941.
17. GURDJIAN, E. S. Traumatic intracranial hemorrhage. *Indust. Med.*, 10: 411, 1941.
18. LYLE, D. J. Eye manifestations of head injuries. *J. A. M. A.*, 123: 873-879, 1943.
19. MUNRO, D. and MALTBY, G. L. Extradural hemorrhage. *Ann. Surg.*, 113: 192, 1941.
20. SHEARBURN, E. W. and MULFORD, E. H. Ambulatory treatment of cerebral concussion. *Bull. U. S. Army Med. Dept. No. 69*, pp. 36-41, 1943.
21. KARNOCH, L. J. Traumatic neuroses and psychoses. *West. J. Surg.*, 49: 606, 1941.
22. PILCHER, C. and ANGELUCCI, R. Analysis of 373 cases of acute craniocerebral injury. *War. Med.*, 2: 114, 1942.
23. WOLTMAN, H. W. Late neurological complications of injury to the nervous system. *Wisconsin M. J.*, 41: 385, 1942.
24. DENNY-BROWN, D. Sequelae of war head injuries. *New England J. Med.*, 227: 771, 813, 1942.
25. DE COSTA, D. G. and ADSON, A. W. Subdural hydroma. *Arch. Surg.*, 43: 559, Oct. 1941.
26. HYDE, T. L. Cotton surgical suture material. *Surgery*, 16: 407-415, 1944.
27. HYDE, T. L. Painful scar and other surgical neuroses. *Am. J. Surg.*, 68: 21-27, 1945.



# HEALING RATE OF HUMAN SKIN DETERMINED BY MEASUREMENT OF THE ELECTRICAL POTENTIAL OF EXPERIMENTAL ABRASIONS\*

A STUDY OF TREATMENT WITH PETROLATUM AND WITH PETROLATUM CONTAINING YEAST AND LIVER EXTRACTS

T. CUNLIFFE BARNES, D.SC.

Associate Professor of Physiology, Hahnemann Medical College and Hospital  
PHILADELPHIA, PENNSYLVANIA

THERE is great interest at the present time in the study of wound healing (Smith and Livingston, 1943; Cook and Fardon, 1942), and scientific methods of measuring the rate of healing are badly needed. Over eighty years ago the founder of the science of bio-electricity, du Bois-Reymond, discovered that an injured bleeding finger is electrically positive compared with an uninjured finger (both digits immersed in cups of saline connected to a potentiometer). Many years later, two surgeons, Melchior and Rahm (1918), reported that wounds involving the skin are positively charged. The positivity of human skin wounds was also determined by Gildemeister (1928) and by Leiri (1934). The writer<sup>3</sup> has called attention to the fact that the concept of interior cellular electrical negativity does not pertain to a *tissue* layer such as skin in which the inner surface is positive. Hence, a wound will be positive. Burr and his associates (1938) (1940) found positive potentials in skin wounds of laboratory animals, confirmed by Burrows et al. (1942). Snodgrass and Davis (1940) (Snodgrass et al., 1943) used the du Bois-Reymond set-up with fingers in cups of saline and reported cuts and abrasions 10 to 20 mv. positive to the intact finger. It is interesting to note that Rehm (1944) found positive injury potentials also in the stomach.

The experiments reported in this paper are an attempt to study the rate of healing of human skin by measuring the wound

potential. By recording the potentials of control wounds made at the same time on the same hand and having approximately the same magnitude, it is hoped that this investigation meets the just criticism of the Council on Pharmacy and Chemistry of the American Medical Association that most studies of experimental healing show "a surprising and regrettable lack of control."

*Procedure.* The method employed is entirely objective. The rate of healing is measured by a recording potentiometer and not by "before" and "after" photographs or attempts to measure visually ill defined areas of healing. Human subjects were used exclusively. The skin of laboratory animals differs from human skin more than any other tissue. Healing agents intended for clinical use should be tested on human skin.

Two homologous finger tips (one from each hand) were dipped into two separate glass dishes holding 10 cc. of 0.9 per cent sodium chloride to a depth of 7 mm. The dishes were connected by agar-saline bridges to two other saline vessels into which dipped non-polarizable Ag-AgCl electrodes leading to a Leeds and Northrup Micromax recording potentiometer accurate to 0.3 millivolt. The bridges protected the electrode cups from contamination or movement in the finger cups. First, the potential difference from thumb to thumb was measured, then from index finger to index finger and so on until the finger to

\* From the Department of Physiology, Hahnemann Medical College and Hospital of Philadelphia.

finger potentials of the hands were completed. Only males were studied owing to a possible electrical asymmetry in females at ovulation.<sup>12</sup> The room temperature and relative humidity were taken at each reading. Snodgrass et al. (1943) claim high humidity increases potential difference between left and right hands. In the present investigation no pronounced effects of room temperature or humidity have been observed but these variables should be recorded in any studies of the skin, and additional data will be analyzed later.

After the normal differences between homologous digits on each hand were measured, the left fingers were sterilized with alcohol and the tips of four fingers were rubbed with sterilized sandpaper until blood appeared. In this type of injury the epithelium has to regenerate and the wound cannot close by contraction as in a cut.<sup>2</sup> The thumbs were left uninjured but their potential was measured at each reading to detect any change in the normal skin of the injured hand; no significant change occurred.

The left hand was used so that the experiment would not incapacitate the subject for daily work. The potential of the fresh wound was measured as the difference between an injured left finger and the intact homologous right finger. There are several reasons for using the skin on the finger tips: (1) The subject can dip the fingers into the electrode cups and record the potentials without technical assistance; (2) a high percentage of skin wounds involves the fingers so that it is important to know the healing powers of skin in this region (Bunnell, 1944); (3) the finger tips are a special area of low electrical resistance.<sup>27</sup>

The wound potential was measured immediately after excoriation and each day thereafter, usually until the disappearance of the wound potential indicated healing. In some cases measurements were not continued to complete healing, as can be seen in Table II. The average duration of the experiments was 32.8 hours

(extremes 10 to 104 hours). (Table II.) Skin temperature was measured with a thermocouple. (Table I.)

Immediately after the first wound potential was measured the wounds were sterilized in alcohol and two fingers were treated with extracts of yeast and liver in an ointment base (1.0 per cent live yeast cell derivative, 3.0 per cent non-saponifiable liver oil, 1:20,000 phenyl mercuric nitrate in lanolin-petrolatum base). This ointment is known commercially as Bio-Dyne ointment.<sup>16,32</sup> The other two fingers were treated with petrolatum as controls. Each of the four fingers was dressed with sterile gauze impregnated with the medication and held by adhesive tape. The gauze did not stick to the wound in any case due to a  $\frac{1}{4}$  inch layer of ointment or petrolatum. No infections were observed at any time. Petrolatum was used on the controls as this formed the base of the extract ointment. There are many favorable reports on the use of petrolatum for dressings.<sup>1,24</sup>

If the wound potential was of different magnitude on the four fingers, the one or ones with the lower potential were resanded until equal to the others. The wound potential of the index finger was usually the lowest; that of the little finger the highest (possibly due to different toughness of skin). In some cases a low and a high were used in each pair. A total of 112 experimental abrasions, each on a finger tip, were measured. Of these, fifty-six were treated with yeast-liver extract ointment and fifty-six served as controls. Of the controls, fifty were petrolatum (Exps. 4 to 28, Table II) and six were dry bandage (Exps. 1 to 3, Table II). Eight persons served as subjects. The experiments fall into twenty-eight groups of four wounds, each group representing the results from one hand. The wound potentials of the two treated fingers were averaged and compared with the average wound potentials of the two control fingers of this hand. Thus, conditions were the same in treated and control fingers.



The percentage loss in wound potential was divided by the number of hours, giving the percentage healing per hour. A similar procedure was used for the two control fingers of the same hand. The percentage of loss of injury potential per hour is termed the healing index in this paper.

example, from handling sharp edges of paper. The person may be unaware of the presence of the cut which can be demonstrated by stinging sensation from alcohol.

The data from the normal skin potentials have been averaged with data from another series since the differences are so slight compared with the large wound

TABLE I

FINGER TO FINGER POTENTIALS. PROTOCOL OF SAMPLE EXPERIMENT (NO. 2 TABLE II). SIGN OF POTENTIAL DIFFERENCE IS THAT OF LEFT HAND, I.E., INDEX FINGER 1.5 MV.-- SIGNIFIES LEFT INDEX FINGER IS 1.5 MV. NEGATIVE TO RIGHT FINGER

Date: Feb. 1, 1944								Feb. 2, 1944		
Time: 4:17 P.M.			5:18- 5:20 P.M.	5:30 P.M.	11:02 P.M.	11:10 P.M.	11:30 P.M.	10:35- 10:45 A.M.	10:50 A.M.	3:44- 3:52 P.M.
Room Temp.: 24°C.					23.2°C.			24°C.		24°C.
Humidity: 33%					32%			29%		26%
To be treated	Index Finger	Normal Potential Before Injury	Tips of all fingers except thumb Excoriated on left hand (bleeding)	Wound Potential	Index and third finger treated with Biodyne. Middle and little finger are controls. All 4 bandaged	Wound Potential	Skin Temperature		Wound Potential	Wound Potential
							Left Injured Fingers	Right Normal Fingers		
Control	Middle Finger	1.5 -				26.1 +	34°C.	35.1°C.	4.2 -	8 +
To be treated	Third Finger	3 +				45 +	34°C.	35.3°C.	33.2 +	17.1 +
Control	Little Finger	1 +				20 +	35°C.	35.3°C.	13 +	1 +
To be treated	Thumb	4 -				12.7 +	34.6°C.	35.1°C.	31.8 +	13 +
		4.5 -				2.5 +			3.6 +	

Calculation of healing indices: Controls (middle and little finger). Initial average 51.5 mv. reduced to average of 15.1 mv. in 22 hrs. = 70.7% healing or 3.21% per hour. Treated (index and third finger). Initial average 48.9 mv. reduced to 4.5 mv. = 90.7% healing in 22 hrs. or 4.12% per hour.

**Experimental Results.** The normal difference in potential between the outside surface of the intact skin of the fingers of the right and the left hand is slight but must be measured before experimental excoriation to detect positive wound potentials from hang nails, slight cuts, and abrasions. The electrical method will reveal small almost invisible cuts obtained, for

potentials. In fifty right-handed males, the average of right to left potentials of the four fingers and thumbs was  $0.86 \pm 0.13$  mv. positive on the right. In twenty left-handed males the average potential difference was almost negligible,  $0.01 \pm 0.18$  mv. positive on the right. It is of interest to note the great variability of left-handed persons. The method of secur-

ing these averages is indicated in Table 1. The normal differences between the five right and left digits in Experiment 2, Table 1 were 1.5+, 3-, 1-, 4+, 4.5+, giving an average of 1.2+. Here the plus or minus sign gives the charge on the right side but in Table 1 the charge on the left side is given because the left fingers were wounded in that experiment.

The temperature gradient across the skin (body temperature on inside, room temperature outside) seems to influence the magnitude of the wound potential which is less when both fingers are dipped into saline at 38°C. (Fig. 1, Part 4.) It was surprising to find that warming the intact finger alone produced a much greater change than warming the wounded finger

TABLE II  
HEALING INDEX OR PERCENTAGE OF LOSS OF WOUND POTENTIAL PER HOUR. CONTROLS 1-3 DRY BANDAGE. CONTROLS 4-28 PETROLATUM. BIODYNE ON TREATED WOUNDS

Experiment No.....	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Controls														
Rate % per hr.....	1.69	3.21	1.15	5.74	5.37	3.46	0.83	2.04	2.10	3.38	3.44	3.57	1.54	0.30
Treated														
Rate % per hr.....	1.89	4.12	1.35	8.40	15.00	2.78	0.40	4.62	1.75	5.07	4.08	4.05	2.04	0.80
Duration of														
Experiment in hrs.....	51	22	43	14	10	22	43	29	16	17	20	18	23	71
Experiment No.....	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Controls														
Rate % per hr.....	1.14	0.23	5.22	3.95	0	3.35	2.61	2.47	1.03	2.64	0.92	1.23	0.30	2.55
Treated														
Rate % per hr.....	1.44	0.59	2.92	3.04	0	3.52	2.91	2.59	1.02	3.52	1.17	2.64	0.66	2.88
Duration of														
Experiment in hrs.....	47	90	24	23	71	24	23	23	72	22	42	23	104	24

In contrast to the small normal potentials from right to left, the wound potentials were 15 to 50 mv. A number of simple experiments were performed to investigate the origin of this injury potential. For example, the "ceiling" value of 40 to 50 mv. can be demonstrated by pricking the finger successively with a sterile needle. Five punctures gave 23.4, 32.6, 36, 36.8 and 42.3 mv., the latter value being equal to the effects of excoriation. (Fig. 1, Part 1, and Barnes.<sup>4</sup>) Beck (1922) claimed that the apparent positivity of the wound was produced by the negativity of the sweat glands at the reference electrode on the normal skin area. However, if the activity of the sweat glands is inhibited by 10 per cent aluminum chloride, the wound potential remains. (Fig. 1, Part 2.) The wound potential of a small burn produced by boiling oil is the same before and after opening the blister (Fig. 1, Part 3), indicating that the potential involves the deeper layers of the skin.

tip. (Fig. 1, Part 5.) The wound acts as an opening or electrical outlet for the positive potential on the inside surface of the intact skin. Hence, warming the intact skin produces a marked effect on the potential, which is measured through the abrasion.<sup>28</sup> Any condition that damages the skin makes the area positive by establishing contact with the positive inner surface. Burns (Fig. 1, Part 3), nitric acid stains (Fig. 1, Part 10), or fungus infection (Fig. 1, Part 11) are positive. Also, in a case tentatively diagnosed as lupus erythematosus, the reddish spots were 30 mv. positive to the adjacent normal skin. It is also probable that the positivity produced by warming the skin is due to increased permeability analogous to the conditions described above. As Snodgrass et al. (1943) reported, the normal potential becomes more positive by about 0.5 mv. for each degree Centigrade of warming. The temperature of the abrasion did not differ greatly from normal skin. (Table 1.)

Regardless of the explanation of the origin of the wound potential, it serves as a valuable indicator of the rate of heal-

extract treated wounds healed at the average rate of  $3.01 \pm 0.28$  per cent per hour (extremes 0 — 15 per cent, fifty-six

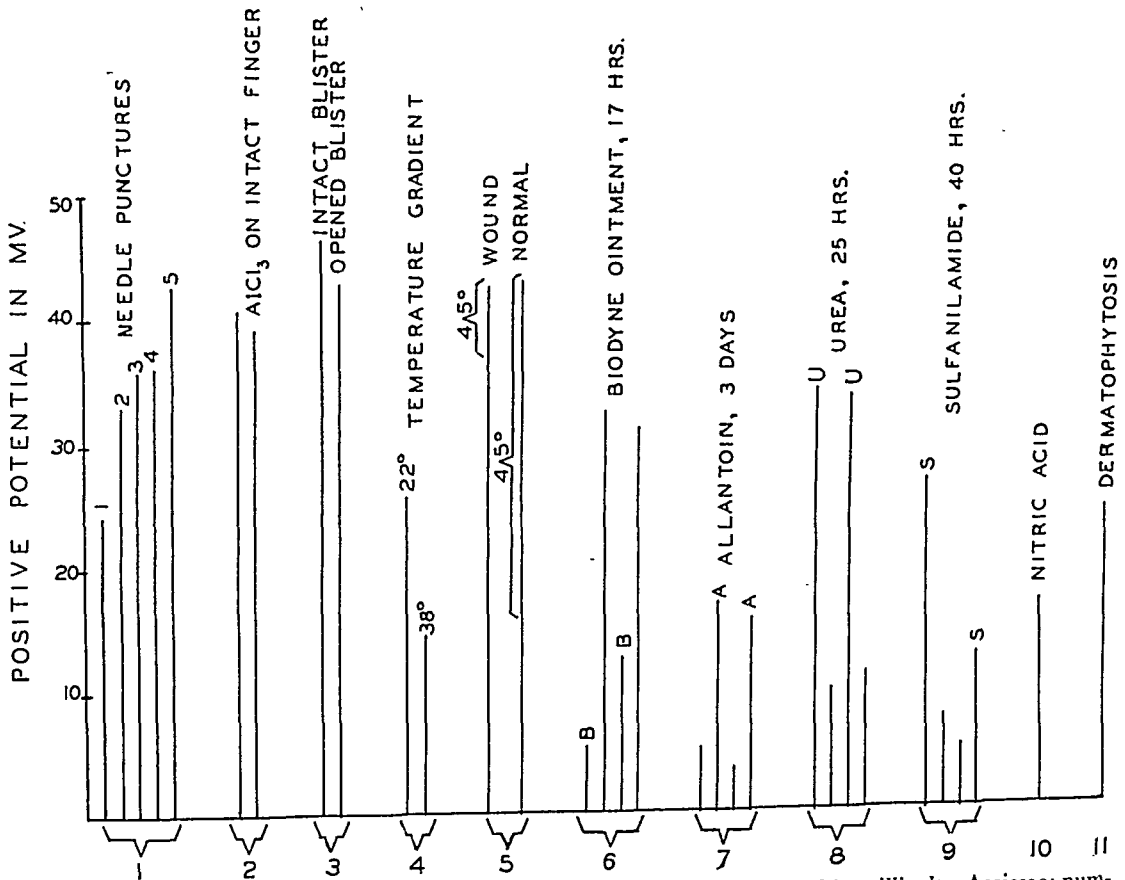


FIG. 1. Positive wound potentials on the finger. Ordinates: electrical potential in millivolts. Ascissae: numbered experiments. 1, effect of driving a needle from one to five times through the skin (reading left to right). 2, inhibition of sweat glands at reference electrode on normal skin. First vertical line: positive wound potential of injured finger measured against potential of opposite intact finger. Second line: same wound potential after application of anhydriotic 10 per cent aluminum chloride on opposite intact finger. 3, positive potential after application of anhydriotic 10 per cent aluminum chloride on opposite intact finger. Second line: same wound potential after opening blister. 4, effect of temperature gradient (inside surface at body temperature; outside surface at room temperature). First line: wound potential with fingers in saline at 22°C. Second line: reduction of wound potential when both fingers are immersed in saline at 38°C. 5, comparison of the small effect of warming the wounded finger tip to 45°C. As Snodgrass et al. (1943) have shown, warming produces electrical positivity. 6, healing action of Biodyne ointment. The four vertical lines represent the four fingers of the hand. B, are biodyne treated, unlettered are controls after seventeen hours. 7, delayed healing by 2 per cent allantoin applied daily for three days. Treated fingers marked A. As in (6) each line represents the wound potential of the four fingers of the injured hand. The first and the third lines show the low wound potential of the control fingers (index and third). 8, delayed healing by 40 per cent urea (treated fingers marked U). 9, delayed healing with sulfanilamide powder applied to wounds (fingers marked S) compared with controls. 10, positive potential produced by yellow nitric acid stains. 11, positive potential at site of infection of "athlete's foot" on finger.

ing. When the wound closes over, the positive potential disappears. Judged by this electrical criterion, the control wounds healed at an average rate of  $2.29 \pm 0.20$  per cent per hour (extremes 0 — 5.74 per cent, fifty-six lesions), while the yeast-liver

lesions). The average healing indices were calculated by dividing the percentage loss in wound potential by the number of hours. (Table 1.) The probable errors were calculated with Peter's formula. The standard deviation of a difference ( $\sigma_d$ ) between

two average values is  $\bar{\sigma}_d^2 = \bar{\sigma}_1^2 + \bar{\sigma}_2^2$ . Taking the average values  $3.01 - 2.29 = 0.72$  and  $\bar{\sigma}_d = 0.34$ , then  $0.72/0.34 = 2.1$ . This order of difference between experimental and control would be expected by chance about 3.6 times per 100, or the odds against getting so great a difference by chance would be 27 to 1.

In a few cases, the wound potential was measured at frequent intervals and it was found that little or no loss in wound potential occurs in the first one or two hours. The method of presenting averages of a large number of cases does not emphasize the great fluctuations in the recorded values. The day to day readings of potential in a sample experiment are given in Table 1 to indicate that the wound potentials are not constant. Nevertheless, significant data can be obtained in a large number of cases, as shown by the statistical treatment given in the preceding paragraph.

As was mentioned above, the 112 lesions are grouped in fours (four fingers of the same hand, Tables 1 and 11) making twenty-eight groups. Of these, twenty-one groups showed faster healing with the extract-containing ointment, five faster with petrolatum, and two groups showed equal healing with both treatments. Thus, 75 per cent of the lesions healed more rapidly with yeast and liver extract ointment, 17.8 per cent healed faster with petrolatum alone, and 7.1 per cent showed no difference in healing rate.

Figure 1, Part 6, shows the effect of the extract-containing ointment on wound potentials in a typical experiment. To illustrate the method, cases of delayed healing by 2 per cent allantoin, by 40 per cent urea and by sulfanilamide are shown in Figure 1, Parts 7 and 8. These less promising treatments have not yet been studied extensively.

#### COMMENTS

The results reported above indicate that electrical methods afford a reliable indicator of the rate of healing. The variation

in the electrical healing index (Table 11) is not surprising and is also encountered with other methods.<sup>8,33</sup> The concept of "wound hormones" in healing is supported by the statistically significant acceleration of healing by the extracts of yeast and liver.<sup>2,15</sup> Other investigators have reported favorable results with this extract.<sup>32</sup> The negative findings of Hirshfeld et al. (1943) were due to their poor technic as they allowed the gauze to dry and stick to the wound in their statistically insignificant human cases.

A word may be said concerning the potentials measured on the intact skin before excoriation. There appears to be a tendency to positivity on the right in right-handed persons. Electrical asymmetry should result from the many differences between the right and the left side of the body.<sup>20</sup> It is possible that the greater movement of the right hand stretches the skin making it more permeable to the inner positive charge. Thus the positive normal and positive injury potentials may have a common origin. Parmenter (1939) found no polarity in right index fingers but Snodgrass, et al. (1943) reported a positive charge on right fingers of fifty right-handed females, supposedly the effect of higher temperature and lower hydrogen ion concentration of the blood in the right hand.

#### SUMMARY

1. Measurements of the electrical wound potential of human skin may be used to indicate the rate of healing.
2. Minor skin abrasions heal at an average rate of 2.3 per cent per hour as indicated by the fall in wound potential.
3. An extract of yeast and liver incorporated in a petrolatum-lanolin ointment accelerates healing of human skin to statistically significant degree compared with control abrasions treated with petrolatum alone.

The author wishes to express his thanks to Dr. O. W. Richards of the Spencer Lens Co.

for statistical analysis of the data, and to Dr. E. S. Cook and Dr. D. O. Meeker for many helpful suggestions.

## REFERENCES

1. ALLEN, H. S. and KOCH, S. L. Treatment of patients with severe burns. *Surg., Gynec. & Obst.*, 74: 914, 1942.
2. AREY, L. B. Wound healing. *Physiol. Rev.*, 16: 327, 1936.
3. BARNES, T. C. Textbook of General Physiology. P. 375. Philadelphia, 1937. Blakiston Co.
4. BARNES, T. C. Positive injury potentials in human skin. *Federation Proc.*, 3: 3, 1944.
5. BARNES, T. C. The effect of left-handedness, temperature, pressure and chemical agents on human skin potential. *Federation Proc.*, 3: 3, 1944.
6. BARNES, T. C. Electrical potential of human skin measured on the fingers. *A. J. M. Sc.*, (Proc. Physiol. Soc. of Phil.), 207: 550, 1944.
7. BARNES, T. C. and COE, R. J. Modifications of the electrical potential of frog skin produced by mechanical factors. *J. Cell. & Comp. Physiol.*, 15: 125, 1940.
8. BAXTER, H., STEVENSON, J. A. F., SCHENKER, V. and BROWNE, J. S. L. The effect of different agents on the rate of epithelial regeneration: use of the dermatome donor area in obtaining clinical data. *Canad. M. A. J.*, 50: 411, 1944.
9. BECK, O. Über den sogenannten Aktionsstrom der granulierenden Wunde. *Zentralbl. f. Chir.*, 49: 1166, 1922.
10. BUNNELL, S. Surgery of the Hand. Philadelphia, 1944. Lippincott Co.
11. BURR, H. S., HARVEY, S. C. and TAFFEL, M. Bioelectric correlates of wound healing. *Yale J. Biol. & Med.*, 11: 103, 1938.
12. BURR, H. S. and MUSSELMAN, L. K. Bio-electric correlates of menstrual cycle in women. *Am. J. Obst. & Gynec.*, 35: 743, 1938.
13. BURR, H. S., TAFFEL, M. and HARVEY, S. C. Electrometric study of the healing wound in man. *Yale J. Biol. & Med.*, 12: 483, 1940.
14. BURROWS, H., IBALL, J. and ROE, E. M. F. Electrical changes in wounds and inflamed tissues. Part 1: The bioelectric potentials of cutaneous wounds in rats. *Brit. J. Exper. Path.*, 23: 253, 1942.
15. COOK, E. S. and FARDON, J. C. The wound hormone concept in wound healing. *Surg., Gynec. & Obst.*, 75: 220, 1942.
16. COOK, E. S., KREKE, C. W. and NUTINI, L. G. Fractions from yeast which stimulate the respiration of yeast and animal tissues. *Studies Inst. Divi Thomae.*, 2: 23, 1938.
17. Council on Pharmacy and Chemistry. A status report on the external use of cod liver oil. *J. A. M. A.*, 121: 759, 1943.
18. DU BOIS-REYMOND, E. Untersuchungen über thierische Electricität, P. 268, Berlin. 1860. Georg Reimer.
19. GILDEMEISTER, M. Die Elektrizitätserzeugung der Haut und der Drüsen. Handbuch der normalen und pathologischen Physiologie. 8: 766, 1928, Berlin.
20. HELLEBRANDT, F. A., NELSON, B. G., and LARSEN, E. M. The eccentricity of standing and its cause. *Am. J. Physiol.*, 140: 205, 1943.
21. HIRSHFELD, J. W., PILLING, M. A. and MAUN, M. E. The use of Bio-Dyne ointment for burns. *J. A. M. A.*, 123: 476, 1943.
22. LEIRI, F. Über die elektrische Doppelschicht der Haut und über die Erregungswelle in den peripheren Nerven. *Skandinav. Arch. f. Physiol.*, 67: 226, 1934.
23. MELCHOIR, E. and RAHM, H. Ueber den Nachweis elektrischer Ströme in der granulierenden Wunde. *Zentralbl. f. Chir.*, 45: 598, 1918.
24. ORR, H. W. Early treatment of gunshot wounds and fractures. *J. Indiana M. A.*, 33: 442, 1940.
25. PARMENTER, R. Direct current potentials associated with human ovulation. *Am. J. Physiol.*, 126: P597, 1939.
26. REHM, W. S. Positive injury potentials of the stomach. *Am. J. Physiol.*, 140: 720, 1944.
27. RICHTER, C. P., WOODRUFF, B. G. and EATON, B. C. Hand and foot patterns of low electrical skin resistance; their anatomical and neurological significance. *J. Neurophysiol.*, 6: 417, 1943.
28. SCHAEFER, H. Elektrophysiologie. Wien. 1940. F. Deuticke. Authority of Alien Property Custodian. 1944. Edwards, Ann Arbor.
29. SMITH, L. W. and LIVINGSTON, A. E. Chlorophyll. An experimental study of its water soluble derivatives in wound healing. *Am. J. Surg.*, 62: 358, 1943.
30. SNODGRASS, J. M. and DAVIS, H. Observations on bioelectric skin potentials. *Am. J. Physiol.*, 129: P468, 1940.
31. SNODGRASS, J. M., ROCK, J. and MENKIN, M. F. The validity of ovulation potentials. *Am. J. Physiol.*, 140: 394, 1943.
32. WALSH, T. F. P. and NUTINI, L. G. Burn therapy founded on cellular stimulation. *South. Med. & Surg.*, 105: 341, 1943.
33. YOUNG, J. S., FISHER, J. A. and YOUNG, M. Some observations on the healing of experimental wounds in the skin of the rabbit. *J. Path. & Bact.*, 52: 225, 1941.



## OPERATING ROOM EXPLOSIONS\*

RICHEY L. WAUGH, M.D. AND LULA BOND, R.N.

BOSTON, MASSACHUSETTS

WOODBRIDGE and Horton<sup>1</sup> after investigating a fatal anesthetic explosion which occurred in Boston in October, 1938, stated: "The explosion in question occurred despite the presence of from 60 to 65 per cent relative humidity in the operating room, electrical connection by chain between the operating table, the gas machine and the floor, and connection between the gas machine and the patient by wire wound around the breathing tubes and embedded in the rubber of the mask and thence by dangle chains to the patient's face. The floor was of terrazzo with embedded brass grids and was grounded. The anesthetist's stool was of painted metal with rubber feet and was covered with a sponge rubber pad finished with a felt-like cloth and protected by a casing of a textile similar to oilcloth or fabricoid. The mask was held in place by a rubber strap passed behind the patient's head. No electrical apparatus was in use other than the usual floor and ceiling lights. Cyclopropane had been administered by the carbon dioxide absorption method in the closed circuit of a Connell DeLuxe machine for about twenty-five minutes. Oxygen had been running at about 250 cc. a minute, no cyclopropane had been added for the last ten minutes and the bag had been staying about half full. It appeared, therefore, that there was no gross leak. As the wound was about to be sutured, the surgeon left the table and had reached a corner of the room when the explosion occurred. There was no other approach to or departure from the vicinity of the operating table and gas machine.

"After the explosion the mask was still strapped to the patient's face, with the cushion ruptured. The posterior pharyngeal wall was lacerated, blood oozed from

the trachea, subcutaneous emphysema developed rapidly and the patient died about fifteen hours later."

Also very recently there was reported a fatal explosion<sup>2</sup> in a New Jersey hospital. The patient was twenty-five years of age and the explosion occurred during a blood transfusion after a chest operation. Death was caused by internal hemorrhage fifty minutes after the explosion.

Such unfortunate occurrences should awaken us to the possibility of a similar explosion occurring in any operating room during the administration of an inhalation anesthetic. Considerable more attention has been devoted to this hazard since the introduction of ethylene and cyclopropane. Few of us, however, realize that the majority of explosions have been associated with the use of ether. In this connection Pinson<sup>3</sup> states that at least one hundred ether explosions occur every year in England. Greene<sup>4</sup> in his report of clinical investigation of 230 cases of fire and explosions in operating rooms found that over half involved ether and air or ether combined with oxygen or nitrous oxide. Fortunately these explosions have been of less serious nature and attended with fewer fatalities.

In accordance with the National Electric Code<sup>5</sup> there were installed in the operating rooms of our new hospital the well known safeguards to prevent explosions. These included electric power circuits with wall and floor plugs explosion proof, the absence of telephones and bell ringing devices likely to produce igniting sparks in the operating room, proper groundings by the inclusion of metal strips in terrazzo flooring and air conditioning with provisions to maintain relatively high humidity in the operating rooms.

\* From the Surgical Service, U. S. Marine Hospital, Boston.

In addition our plans were to use other known measures to prevent electrostatic sparks, i.e., the use of the Horton inter-coupler, conductive rubber for feet and casters of metal furniture and in addition drag chains for the metal furniture, conductive rubber mattress and pillow covers and lastly the wearing of shoes with conductive rubber soles by operating room personnel. The war situation, however, has prevented us going the full way particularly in obtaining all recommended conductive rubber articles.

This knowledge of proper safeguards for the operating room has resulted in making some of us "operating room explosion conscious." This perhaps has caused us to go to the other extreme, at least at times, in the choice of the anesthetic. For example, in some instances we may have chosen spinal or intravenous anesthesia rather than inhalation with consequent risk of explosion, but a far greater risk so far as the patient himself was concerned. It is expected, however, that with the installation of all the possible safeguards, we should be able to make the choice of anesthesia entirely from the standpoint of operation and surgical risk involved.

The more commonly used inhalation anesthetics (ether, ethylene and cyclopropane) form explosive mixtures with oxygen. Therefore, to prevent explosions by ignition requires in addition to the proper electric power circuits, a knowledge of electrostatic discharges. This subject was presented in excellent form by Tovell<sup>6</sup> in the Bulletin of the American College of Surgeons in January, 1941.

In the prevention of operating room explosions, it is essential that all operating room personnel and others engaged in hospital administration be thoroughly familiar with these hazards and the necessary safeguards. This is difficult in practice particularly with frequent change in personnel. The pamphlet<sup>7</sup> by the National Fire Protective Association is very comprehensive. However, on account of its many pages it has been impossible to get

others to familiarize themselves with the context of this very important pamphlet. Therefore, in an attempt to disseminate this important information, the following digest or practical outline for the prevention of operating room explosions was prepared and posted in a rather conspicuous place in the entryway to our operating rooms.

We believe this has been of considerable help in introducing the subject to new operating room personnel and also as an aid in keeping all of us consciously alert to the hazards of fire and explosion. The outline is as follows:

#### PREVENTION OF OPERATING ROOM EXPLOSIONS

The need for taking steps to prevent operating room explosions is shown by the following excerpts from the address of Professor Horton\* of Massachusetts Institute of Technology:

"Among the hazards of modern existence, the possibility of death by explosion while anesthetized undoubtedly causes little general concern. It is a fact, however, that during many operations the gaseous mixture introduced into the patient's lungs has such physical properties that it might easily be used for the operation of an internal combustion engine. Actually, the flame velocities observed for some anesthetics in wide use are among the highest encountered in combustible gases. Obviously, the accidental ignition of such anesthetic gases during an operation can scarcely fail to have disastrous consequences.

"Nor is this potential risk merely theoretical. In a group of some 60 of the leading anesthetists of the United States and Canada, which met about a year ago, there were 5 anesthetists, each of whom had been involved in a fatal anesthetic explosion. No two had been involved in the same explosion. Such statistics as have been compiled indicate that, on the aver-

\* Presented at the annual meeting of the National Fire Protection Association, Toronto, May 12-16, 1941.

age, out of every 50,000 to 100,000 administrations of combustible anesthetics, one results in a fatal accident.

"With respect to these explosions the medical profession is divided into two groups, those who have had one and those who have not had one. Those who have had an explosion never forget it, nor are they likely ever again to administer an inhalation anesthetic without a silent prayer. The emotional factors involved in an anesthetic explosion make it one of the most dreaded of all disasters by those familiar with its possibilities.

"All ether compounds and hydrocarbon anesthetics are combustible and are explosive when mixed with oxygen. Nitrous oxide and chloroform are not combustible but nitrous oxide can form inflammable mixtures with ether or with the hydrocarbons. Each of the several combustible agents has its own individual characteristics. 'Ether, for example, disperses slowly and may flow to a considerable distance from the point of use. It has frequently been known to form a virtual fuse from a wall receptacle to the operating table. Cyclopropane, on the other hand disperses rapidly and is seldom found in dangerous concentrations at distances of more than a foot or so from the anesthetic administering equipment. However, cyclopropane is frequently used in concentrations having high flame velocity and which, when ignited, results in explosions of great severity.'"

More than ten years ago, the National Board of Fire Underwriters, perceiving the need of safeguards in this field, invited the cooperation of the hospital authorities of the United States, the Surgeons General of the Army, the Navy, the Public Health Service and other interested parties to study the problem and to outline the necessary safeguards. This was accomplished and since that time the National Board has continued to assist the hospitals of the country in meeting and solving the many problems of safety brought about by the rapid progress and developments in

the field of anesthesia. At the request of the National Board, this project has been taken over by the National Fire Protection Association; and the committees on Gases and Operating Room Hazards have recommended certain safe practices for the use of combustible anesthetics in hospital operating rooms.

With the hope that all personnel and other persons entering our operating rooms will have a better understanding of these safe practices, the following outline has been prepared:

*The Principal Preventive Measures.* I. Proper installation of electrical equipment so that sparks or arcs in electric wiring will be prevented; circuits, and switches should be explosive proof. All groundings should be in accordance with the National Electric Code.

II. *Prevent electrostatic spark discharges.* a. Horton intercoupler provides effective pathway for potential equalization between conductive bodies, i.e., gas machine and leads to patient, anesthetist, operating table and ground.

b. Accumulation of static electricity may be prevented by various means, i.e.

1. Patient should not be moved from one room to another while an inhalation anesthetic is being administered.
2. Woolen blankets should not be permitted in the operating room.
3. Persons or objects outside the intercoupler system should not be allowed within the region of possible escape of explosive gases without first making contact with one of group in system at a point remote from the danger zone.
4. Carbon dioxide absorption method of administering anesthetic agents is an added safeguard if other measures against hazards of explosion are maintained.
5. High relative humidity should be maintained—should be at least 55 per cent, but 65 per cent is not safe if carbon dioxide content of air is



reduced which sometimes happens in air conditioned operating rooms.

6. Mask and breathing tubes should be washed before using.
7. Breathing bag should not be removed from gas machine while it contains explosive mixtures as flushing inflammable gases from the machine with oxygen is extremely dangerous.
8. Cloth covers should not be used on gas machines because static discharges might occur when they are removed.
9. Withdrawal of cotton covering from a non-conductive rubber cased pillow should be prohibited.
10. Sponge rubber cushion on the stool of the anesthetist should not be permitted.
11. Outer garments of silk or rayon or uniforms of "shark-skin" should not be allowed.
12. Properly conductive flooring is increased by repeated washings with calcium chloride, from 2 to 4 per cent, which will cause floor to retain moisture.
13. Keep persons with nails or metal plates in shoes out of operating room. Also shoes with soles of rubber or composition must never under any circumstances be permitted in the operating room unless some effective means is employed to overcome their electrostatic action. Leather soles, particularly if damp, (as in winter, but not in summer when soles are dry) may be permitted.
14. Drag chains on all furnishings should be bronze rather than of iron or steel.
15. Feet on metal furniture should be covered with conductive rubber.
16. Coverings of all operating tables and stretcher pads and of all pillow cushions and the like should be fabricated from sheeting of conductive rubber. Also waterproof sheet-

ing and rubber or equivalent parts of operating room equipment, i.e., masks, breathing bags, breathing tubes and gaskets of anesthesia equipment and all suction and pressure tubing not confined within a metallic sheathing should be of conductive rubber.

III. Spontaneous combustion may occur if the oxidizing and reducing gases are permitted to mix under high pressure. Rooms in which hydrocarbon anesthetic gases or any of the other compounds are stored or used are to be considered a "hazardous location." These locations should be ventilated by mechanical means (air brought into room in ducts opening not less than 6 feet from the floor and removed by ducts not more than 3 feet from the floor). Cylinders containing compressed gases and cans containing volatile liquids should be kept away from radiators, steam pipes, and like sources of heat. Cylinders containing reducing gases, such as ethylene or cyclopropane, and cans containing inflammable liquids, such as ether, should be kept out of proximity to cylinders containing oxidizing gases, such as oxygen and nitrous oxide. Also inflammable material, such as wood and fabrics, should not be stored or kept near cylinders containing oxygen. Containers and anesthetic equipment not in active use should not be covered with fabric or other covering at any time.

Care should be taken to prevent accumulation of grease or oil on cylinders containing compressed oxygen and such cylinders and fittings should never be wiped with cloth, waste, or similar material likely to contain oil or grease. No equipment should be used for coupling cylinders containing compressed gas which might permit the inter-mixing of gases. Also compressed gas should never be transferred from one storage cylinder to another on the hospital premises.

IV. Open flames and hot bodies may cause ignition of inflammable gases, and the most effective safeguard is a continuous

consciousness on the part of the operating room personnel of this danger.

*Last but Not Least.* Each individual entering an operating room should be thoroughly instructed and should remain consciously alert to the hazard of fire and explosion—unrelenting vigilance should be directed toward preventing explosions.

#### REFERENCES

1. WOODBRIDGE, PHILIP D. and HORTON, J. WARREN: Prevention of ignition of anesthetic gases by static spark. *J. A. M. A.*, 113: 740-744, 1939.
2. Explosion of anesthetic kills patient. *J. A. M. A.*, 120: 1049, 1942.
3. PINSON, Cited by Tovell, Ralph M.<sup>6</sup>
4. GREENE, BARNETT A. The hazard of fire and explosion in anesthesia: report of a clinical investigation of 230 cases. *Anesthesiology*, 2: 144-160, 1941.
5. National Electric Code. National Board of Fire Underwriters, 85 John Street, New York, N. Y. November, 1940.
6. TOVELL, RALPH M. Anesthetics—physical hazards: explosibility and inflammability; remedial measures. *Bull. Am. Coll. Surgeons*, 26: 26-28, 1941.
7. Combustible Anesthetics and Operating Room Explosions. National Fire Protection Association International, 60 Batterymarch Street, Boston, Massachusetts.



It is essential that the anaesthetist should bear in mind the possibility of blast before he anaesthetizes the patient for an operation elsewhere in the body. If a patient suffering from blast must be operated upon, local or intravenous anaesthesia should be employed.

From "Surgery of Modern Warfare" edited by Hamilton Bailey (The Williams and Wilkins Company).

# THE TOURNIQUET\*

## ITS CLINICAL APPLICATION

ROBERT T. McELVENNY, M.D.

Attending Orthopedic Surgeon, Wesley Memorial Hospital

CHICAGO, ILLINOIS

THE purpose of tourniquets is twofold. The first is to prevent the return of venous blood from an extremity; the second is to prevent arterial blood from entering an extremity. For these reasons tourniquets are referred to as venous tourniquets and arterial tourniquets.

The venous tourniquet is of value in certain tests and in procedures that require vein puncture, section, ligation, etc. With these uses the tourniquet offers little danger. The pressures used are slight and the time intervals of application are usually of short duration.

With the arterial tourniquet the conditions are reversed. The pressures used are great and the time intervals of application are comparatively long. For these reasons the dangers inherent in the application of tourniquets belong almost exclusively to the arterial type.

Although the tourniquet as such has been known and used by man for centuries, the fear of damage to the part and the individual are still potent factors in limiting the wide use of tourniquets in the field of extremity surgery. The tremendous advantages afforded the surgeon and the patient by a well applied tourniquet should so outweigh the comparatively slight chance of accident that it is the purpose of this paper to discuss the accidents and the misfortunes that occur with their application during the routine uses in extremity surgery. Further, it is the purpose of this paper to discuss the causes for these accidents and to describe the technic that has been developed for tourniquet application in large institutions over a

long period of years and in thousands of applications.

In reviewing the literature on tourniquets as applied to the experimental animal, one is impressed with the fact that the interpretation of results is many times faulty and the series of cases comparatively small. The conclusion is that the experience with the human as regards tourniquet application offers more actual and factual information for the surgeon than do the laboratory experiments.

In summing up the laboratory experiments we find facts that coincide with the experiences offered by the human. Among these are the following:

1. The harm a tourniquet can do varies with the size, shape, and characteristics of the part. This is noted also as to species. For instance, the hind leg of a rat is easily paralyzed by a tourniquet that is harmless when applied to the hind leg of a cat, dog, or rabbit. The latter have stronger and tougher tissues than the rat, in addition to other marked differences.

2. If a tourniquet is left on for hours, say four to five, the limb after the constrictor is released develops a reactive hyperemia with all the phenomena of inflammation. The intensity of the inflammatory reaction is in proportion to the length of application. This has been observed repeatedly in the human and is one of the factors that limits the time a tourniquet can be left in place.

3. If a tourniquet is left on an experimental animal's leg for many additional hours than the above, no reaction is noted until the tourniquet is removed. The first reaction is hyperemia of the limb. This is

\*From the Department of Bone and Joint Surgery, Northwestern University Medical School.

then followed by inflammation, and then marked edema. Although the part may recover as judged by its appearance, one does not find out because the animal develops a typical secondary shock. This is irreversible and ends in death. This has also been observed in man. Cannon mentions a case during World War I of an officer whose thigh was crushed between logs for twenty-four hours. On removal of the logs restoration of circulation occurred in the limb but this was followed by secondary shock and death in a few hours. In the experimental animal, amputation of the affected limb previous to removal of the constrictor prevents the development of secondary shock.

4. Paralysis occurs in the limbs of animals from pressure on nerves. This has been observed in the human and is one of the common complications of tourniquet application.

5. Paralysis also follows tourniquet application in animals but in many cases this is thought not to be due to pressure on the nerves but to local asphyxia of the nerves. This may be so but in this writer's opinion the facts on which this is based are not too clearly defined. This reaction may be related to the pathological condition encountered in leaky tourniquets.

The above facts are pertinent to the practical use of tourniquets. Most of them have been observed in the human. The practical application of a tourniquet for operations on the human must avoid ill effects both local and general. To put on a tourniquet, then, that is absolute, safe, and can be used routinely, requires practice and skill.

This writer has been using tourniquets routinely for the past ten years on all but the most minor procedures. These tourniquets have been applied repeatedly to toes, fingers, and the upper and lower extremities. In this period he has had one case of paralysis and this in the upper extremity. There has been but one other complication in his personal experience. Both of these cases will be described.

Further, he has witnessed, during this time, and worked with others, where the application of tourniquets number in the thousands. In this time he has observed two upper-arm paralysis and one Volkmann's paralysis in the lower extremity. It is to be noted that these cases occurred in institutions where practice and skill in tourniquet application was on a high plane.

The occasional and rare accidents that occur with the use of the tourniquet are generally due to four causes: (1) The tourniquet is too tight; (2) the tourniquet is too loose; (3) the tourniquet has been left on too long; or (4) the tourniquet has been applied with no consideration for the anatomy of the part. It is to be noted that all of these causes reflect not on the patient, but on the person responsible for the application of the tourniquet. The success of a tourniquet then depends on the judgment, the care, and the skill used by the person applying the constrictor.

#### GENERAL CONSIDERATIONS OF TOURNIQUET APPLICATION

*Material.* Improperly used there are objections to all types of tourniquets. When properly used a few types of tourniquets are superior to all others and should be used in preference to all others.

The effect of a good tourniquet is to put pressure on the tissues surrounding the blood vessels (and nerves) sufficient to prevent any blood passing the constriction but without harm to these structures. This pressure must be absolute and absolutely maintained for the period of application. These tissues while compressing the blood vessels and nerves should also surround them and act as pads for these structures.

Tourniquets composed of cord or metal need only be mentioned to be avoided except in special fields such as chest surgery. There have been many types of tourniquets devised but none that we have tried are as safe or as dependable as the types recommended here.

Rubber tubing, except as small bands to be used on fingers and toes, is unsatisfactory as tourniquet material. It does not allow wrapping over and over itself and is difficult to control. The rubber tube constriction depends on one wrap and therefore is under great strain. Consequently it disintegrates rapidly, breaks frequently, cuts deeply into the flesh and in all ways is inferior.

The wide rubber bandage, three inches or more, composed of thin sheet rubber, and known as the Martin bandage, is excellent for expressing blood from an extremity in preparation for tourniquet application but should not be used as a tourniquet. The reason for this is that the pressure applied depends on the wrapping of layer over layer. The pressure here is almost impossible to control. Many times the application is too loose, while at other times the pressure exerted by this bandage is overwhelming. This bandage is dangerous as a tourniquet and should not be used.

The most practical, the safest, and the best elastic tourniquet is the strap type rubber tourniquet with the chain and clasp. It is known as the Esmarch. This tourniquet is dependable, easily mastered, uniform in length and stands up well. The standardization of its length and thickness prevents tremendous pressures being applied. With any consideration and any judgment at all, it can be used routinely with no trouble. It may be applied too loosely but with any care it can seldom be applied tight enough to cause any damage. It is used in but one situation and that is in the middle or upper thigh. It is used nowhere else.

The pneumatic tourniquet is a rubber cuff that is inflated with air by means of a pump. The pressures are transmitted to a gauge attached to the apparatus and can be determined by glancing at the gauge. This tourniquet is the most logical of all. It can be absolute, and the pressures can be maintained, increased, or lowered with ease and under absolute control. It is the tourniquet of choice.

The only troubles with it are technical. There is no excellent one in the market. Too frequently the valves leak, the rubber tubing blows out, the cuff leaks or blows out, or the tourniquet creeps thereby releasing pressure and allowing arterial blood through. In general, the materials used are inadequate for the job the tourniquet has to do. To date it is not as dependable for routine work on the lower limb as is the Esmarch.

The two types of pneumatic tourniquet in use are various commercial types that record pressures in pounds per square inch and the blood pressure cuffs which record pressures in millimeters of mercury. One pound pressure is equivalent to a pressure of 51.7 mm. of mercury. We use the commercial type of tourniquet for the lower extremity and the blood pressure cuff for the upper extremity. (Fig. 1.)

The Esmarch tourniquet and the Martin bandage are often sterilized by heat so that they may be applied under sterile conditions. In routine elective surgery there is no need for this. The heat used, especially the autoclave, rapidly affects the rubber and it becomes weak and breaks readily. A satisfactory routine used by this writer is as follows: All operations on extremities include the preparation of the hands including the fingers and the foot including the toes. The elastic bandage is started at the fingers or toes over the sterile preparation which is covered by towels and is wrapped firmly to the point at which the tourniquet is applied. The tourniquet is applied, the elastic bandage is removed and the limb is ready to prepare for the actual surgery. (Figs. 2, 3 and 4.) To make the handling of the Esmarch and Martin bandages easier and to preserve them, they are occasionally powdered with talcum.

*Patient.* Age is no contraindication as to the application of a tourniquet. Countless numbers of tourniquets have been applied to children and to the very aged. In this writer's experience, no mishaps have occurred and he has not observed

any. Many of these old people have had marked calcification of the arteries as shown in the roentgenograms. The wound healing has been as prompt as in similar cases in younger age groups.

Tourniquet pain is often referred to as a complication of tourniquet application. This is not the case. The only tourniquet pain complained of in properly applied tourniquets is at times a feeling of heaviness about the thigh. This is rarely complained of by the patient but can be elicited at times by close questioning. We have rarely observed this in cases of arm tourniquets. This mild discomfort in our opinion is even less with pneumatic tourniquets on the lower extremity than with the Esmarch. In general, the patient is unaware that a tourniquet has been applied in either instance.

With the advent of modern anesthesia, spinal anesthesia, never popular in bone and joint work, has become less so. On a large series of patients that were done under spinal, it was noted that tourniquet pain was bothersome to quite a number on whom the tourniquet was applied although the anesthesia was well established. This pain in the lower extremity would begin twenty to thirty minutes after tourniquet application, rapidly increase in intensity, and require the release of the tourniquet. On the other hand, a tourniquet in the routine fashion has been applied on many patients, using a pneumatic cuff to the upper arm or the lower leg and the operative site blocked with local infiltration of novocaine. The entire procedure has been carried out under a local anesthetic with the patient not complaining at all of the tourniquet which we have left on for as long as forty minutes. These phenomena have called forth various explanations, none of which seem entirely adequate.

*Technician.* An intelligent cooperative technician can be trained to apply tourniquets with skill and judgment. Under no circumstance should this be allowed except under the direct observation and direction

of the surgeon. The technician should be instructed as to the following:

1. Under no circumstance is any tourni-

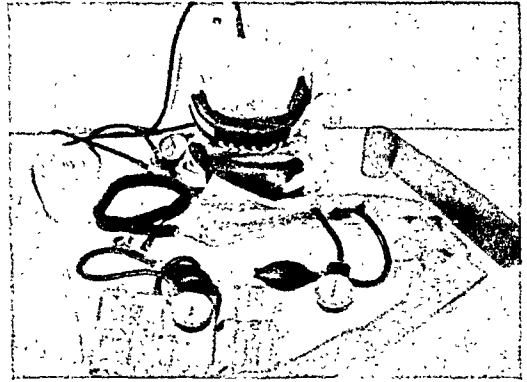


FIG. 1. Illustrates our collection of tourniquets and accessories: Roll of elastic webbing, Esmarch tourniquet, pneumatic leather cuffs as developed by Mr. Gregory Sullivan, Martin bandage, ordinary blood pressure cuff, and creep-proof blood pressure cuff. Note that ordinary blood pressure cuff is folded on itself in manner used for high-arm tourniquets.

quet except a pneumatic type allowed on the upper extremity. This tourniquet by choice is a blood pressure cuff. This rule has no exceptions in elective surgery. This tourniquet can be applied to either the forearm or the arm under the direction of the surgeon.

The technician is shown the relationship of the radial nerve to the humerus and shown at what level this nerve crosses the radial side of this bone. The proximal extreme of the arm is shown to the technician and the relationship of all the nerves and vessels to the humerus on the axillary side of the bone is explained. It is emphasized that these vital structures in the arm are deep and that any excessive pressure anywhere in the arm and especially at the above two areas will press the nerves not against their surrounding tissues but against bone. It is pointed out that this bone is unyielding and that the pressure of the nerve against it will cause paralysis.

2. The relationships of the similar structures in the thigh are explained. It is shown why the middle and the upper thigh are tourniquet sites. The tibia is

demonstrated, showing how with rubber tourniquets the pressure of bone against skin can bruise or necrose tissue. For this

made to check with the anesthetist to see that she has recorded the time of application of every tourniquet.

FIG. 2.



FIG. 3.

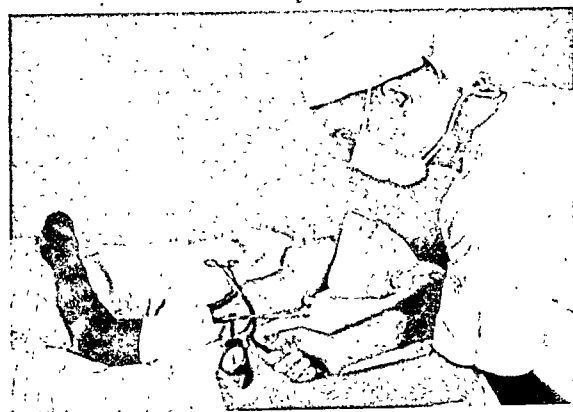
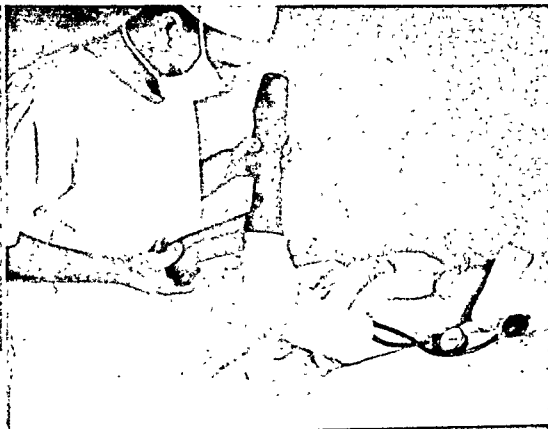


FIG. 4.

FIG. 5.

FIG. 2. Illustrates the application of the creep-proof blood pressure cuff. Note that this is applied above where the radial nerve crosses the lower front of the humerus. Note that this cuff is applied directly on the skin. FIG. 3. The cuff has been applied and is wrapped with gauze to keep the extra portion of the cuff in place. The Martin bandage is being applied in preparation to inflating the cuff.

FIG. 4. The Martin bandage is applied, the cuff has been inflated to proper pressure. Note the clamps on the rubber tubing to prevent leaking. The clamp on the gauge tube will have to be removed frequently to check pressure. This is done by the anesthetist. Note position of cuff in relation to distance from elbow. If narrower, these cuffs would be more satisfactory.

FIG. 5. Shows method of applying a high-arm tourniquet for operations on the elbow and above. Note that an ordinary blood pressure cuff has been folded on itself and then wrapped about the arm over three pieces of gauze bandage. These strips of gauze are tied as illustrated to prevent bulging of the cuff and was suggested by Dr. Carl Berg, of Washington, D.C.

reason the risk in the thigh at the proper level is less than in the tibia and, therefore, should be the only site for the routine application of the rubber tourniquet on the lower extremity.

3. He is taught the correct pressures for arm and thigh tourniquets and how to maintain them.

4. He is taught the safe limits of time the tourniquets should be on and he is

5. The technician is brought into the operating room and shown the results of his work. He learns what the operative field should look like and he learns what a leaky tourniquet turns an operative field into.

6. If any complications develop, the technician is taken to the patient and is shown the results of our poor judgment and skill.

The technician is then limited in tourniquet application to the following:

1. The area of the arm beginning four fingers breadth above the insertion of the deltoid muscle into the humerus and extending to three fingers breadth below this insertion. Only a pneumatic cuff can be used.

2. The forearm, using a pneumatic cuff only. This cuff must start three fingers' breadth below the elbow joint and go distally.

3. The thigh. A tourniquet can be applied nowhere on the lower extremity except in the middle or the upper third of the thigh. The rubber Esmarch or the pneumatic cuff type may be used here.

*Routine.* The night before the extremity is washed gently with gauze using soap and water. The part is shaved. The toe nails or finger nails are thoroughly cleaned. The gentle washing is then continued for five minutes. The soap is washed off with water. The part is then dried off with ether. The part, including the toes or fingers, is completely wrapped with sterile towels. These towels are wrapped snugly with gauze bandage over which adhesive tape is spiraled and ultimately attaches to the skin above the line of preparation. At the time of operation, while the patient is asleep these dressings are removed and under sterile precautions, the whole area is washed gently with soap and water for fifteen minutes. The part is rinsed with sterile water, then alcohol. The part is then rewrapped in sterile towels and now is ready for the application of the tourniquet. (Figs. 7 and 8.)

The extremity is elevated and an elastic bandage is wrapped firmly about the limb beginning at the tips of the fingers or the toes. This wrapping is continued up to the site of the tourniquet application. With the extremity still elevated, the tourniquet is applied. The elastic bandage is then removed. The limb is stripped of its towels and under sterile precautions is washed with ether. We seldom use skin antiseptics or dyes. The limb is now draped. (Fig. 10.)

The Esmarch tourniquet, contrary to accepted thought, is less harmful if applied in layers, one exactly over the other. We try to get this on covering the narrowest surface possible. It takes as much pressure over a broad surface as a narrow surface to occlude a vessel at a particular point. A narrow band, therefore, produces less tissue damage than a wide band. The patient should be asleep and before the tourniquet is applied, the adductor muscles should be palpated to see that they are not in spasm. If they are, the tourniquet may leak after the spasm has passed because the pressure lets up. The Esmarch can be placed directly on the skin but we prefer a towel folded in three layers and wrapped about the limb. Over this the tourniquet is applied. (Figs. 9 and 10.)

The chain end is placed on the lateral side of the thigh. The right hand passes under the thigh, seizes the rubber next to the chain. The tip of the tourniquet holding the chain end is held firmly against the thigh by the other thumb and forefinger. The rubber is then pulled taut with the thumb and forefinger of the right hand. As one pulls he allows the rubber to slip through his thumb and finger as he brings the band under and up around the thigh. Done properly, this slipping produces a "singing" sound from friction. As soon as the band reaches the tip of the tourniquet that is held by the left thumb and forefinger, the tension is maintained by the left thumb pressing this band firmly against the tip of the tourniquet. The right hand then passes under the thigh again, up over the medial side, and then over the top of the leg, grasps the band just at the tip of the left thumb, and pulls it taut in the fashion described, being sure that the second layer of rubber is directly over the first layer with no skin or toweling caught between them. This is repeated again and again until all the tourniquet is utilized. The chain and hook are then connected. In removing this tourniquet, the thumbs are placed on opposite tips of the tourniquet and the tips are pressed



down and towards each other. This unhitches the tourniquet with very little effort.

The pneumatic tourniquet in addition

even when the pressure is at the point where all circulation should cease in the limb. The reasons for this are the following:

FIG. 6.



FIG. 7.

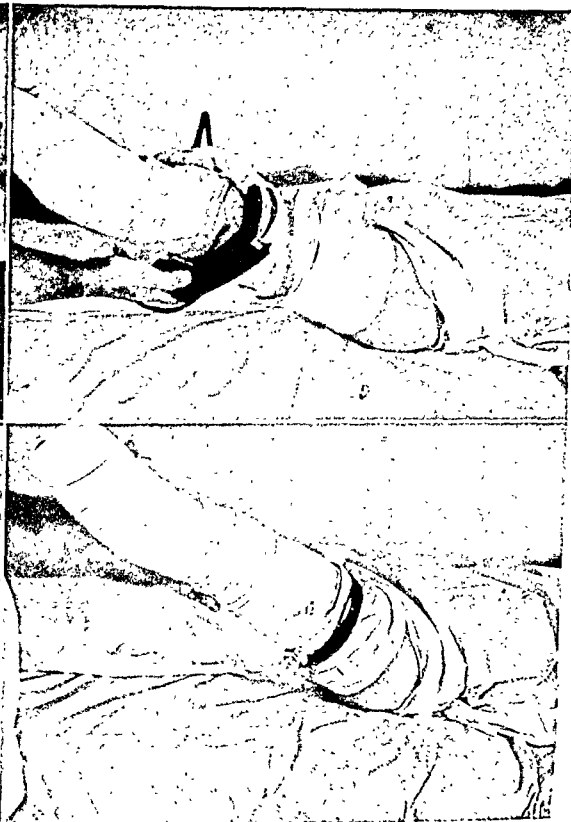


FIG. 8.

FIG. 6. Illustrates the high-arm tourniquet applied. The cuff and the gauze ties have been covered with several layers of gauze bandage which extend slightly above and below the margins of the cuff. This gauze is then covered completely with a layer of adhesive. This will prevent creeping of the cuff and loss of pressure. Note the clamps on the rubber tubing. To remove, a bandage shears are run between the gauze and the cuff.

FIG. 9.

FIG. 7. Shows type of drape used after final scrubbing of limb just before tourniquet application. Note circle of thin felt about thigh and method of placing pneumatic cuff about thigh. These cuffs have been developed by Mr. Gregory Sullivan and have proved the most satisfactory type we have used. They are constructed of a good grade of leather and rubber. They stand up well and maintain pressures without leaking or creeping. All of these cuffs are adjustable to fit any thigh, but Mr. Sullivan keeps many already set up in different sizes which need no adjustments and are slipped over the limb as illustrated and pushed proximally until they are snug. They are then inflated. After the air is released they are taken off the same way they are put on. Since the thigh tapers, only two sizes are needed for the adult, if one wishes not to adjust them. (See Fig. 1.)

FIG. 8. The pneumatic cuff in place, showing it snugly fitted to the upper thigh over the felt ring. Note elastic bandage about limb and over sterile drape. Note that limb is elevated. The elastic bandage is composed of a weaving of cloth and rubber. It is quicker to apply to a limb and stands more abuse than does the Martin bandage.

FIG. 9. Close-up view to show Esmarch tourniquet in place over a towel which has been folded longitudinally to form three thicknesses. Note the fine wrapping of the elastic webbing about the knee and thigh as compared to the wrapping on the leg.

to the faults that may defeat it requires much skill in its application if it is to be effective. The commercial cuffs do not creep but at times fail to occlude blood

1. If one will take the reading of the tourniquet when pumped up but before the elastic bandage is removed and then remove the elastic bandage a few turns,



FIG. 10.

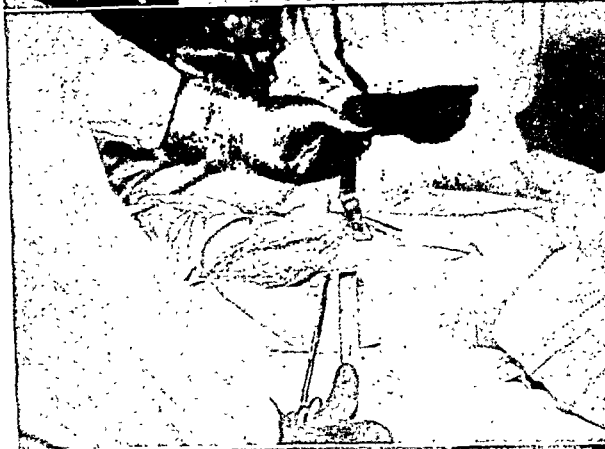


FIG. 11.

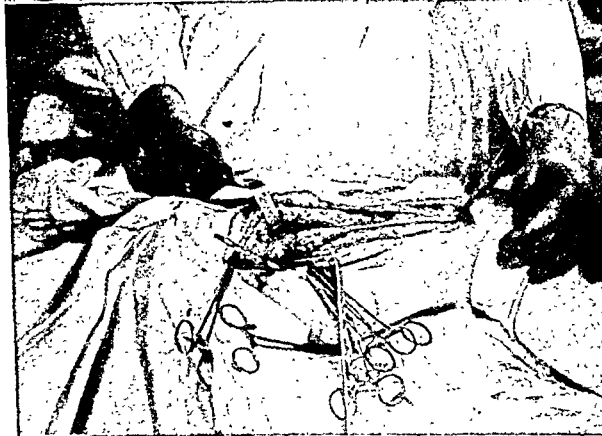
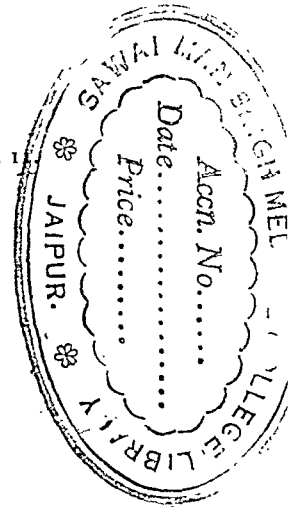


FIG. 12.

FIG. 10. Shows limb with Esmarch tourniquet applied high on the thigh to allow operation on practically the whole length of the thigh. Note that sterile towels have been removed following removal of elastic bandage and that the whole limb is now ready to be sponged with ether and then draped. The limb is elevated for sponging with ether and this is when the ether or tinctures, if used, are likely to run down the limb and be absorbed by the tourniquet towel and produce burns. Note how closely the two ends of the tourniquet are hooked together. This makes for easy removal. Contrast with Figure 9.

FIG. 11. Same case as Figure 10, showing effect of tourniquet. Note stockinet below knee. This ordinarily would



he will note that the tourniquet pressure will drop from two to three pounds. This is because in the firm wrapping of the elastic bandage the tissues have been squeezed proximally increasing their volume at the site where the tourniquet is applied. When the elastic bandage is removed the tissues then flow out from under the tourniquet, thereby lowering the pressure. It is our custom to watch this point and by adding air, maintain the tourniquet at its correct pressure as the elastic bandage is removed.

2. The rubber tube inside the inelastic cuff is limited in expansion by the size of the cuff. Readings of actual pressure on the gauge may be misleading because of the inelastic cuff. It is readily appreciated that if the tourniquet is applied loosely about the thigh, the rubber bag may expand to its limit against the inelastic cuff which will give a high pressure reading on the gauge, but actually very little pressure of the cuff on the leg will result.

3. The blood pressure cuff must be applied with care and the figures illustrate the technic used in applying it. The non-slipping type is very satisfactory for the arm. The only criticisms are that it is too wide, its valves are faulty and its connection poor for maintaining pressures without leaking. The same decrease in pressures in the arm using the cuff occur as in the leg upon removing the first turns of the elastic bandage. (Figs. 2 to 6.)

4. The elastic bandage gives a bloodless extremity below the elbow and knee with only light application of pressure. In the arm and thigh this is not the case and over these areas the bandage should be wrapped closer together and much more firmly because the mass of tissue is greater and

it takes more pressure to express the blood. (Figs. 8 and 9.)

The ideal tourniquet is one which does no harm and gives a perfectly dry, white, bloodless field. This is more difficult to obtain in the thigh and in the arm than below the knee or elbow. The only blood encountered should be cherry red, not blue or black, and should never ooze. When a vessel is severed, if any blood is seen, it should be a drop or two only and when sponged away there should be no more from these points. The bone when cut into should be for the most part a definite yellow color with little if any reddish tinge to it. (Figs. 10 and 11.)

The advantages of such a field are many: (1) The operation is more neatly and quickly performed; (2) structures such as blood vessels, tendons, and nerves are more easily identified; (3) since time is saved and sponging and wound wiping are practically abolished, the trauma is much less; and (4) in any procedure dirt from various sources settles in the wound. If no tourniquet is used, the bleeding occurs at the start of the operation and then decreases as the operation proceeds. All the dirt that has settled in the wound is closed up in the wound without dilution unless the wound is irrigated with such a solution as warm saline.

In wounds made under tourniquet, it is customary in our hands to cut and tie all vessels as the operation proceeds. In large wounds that offer a fair chance for sepsis, we customarily irrigate those with warm saline using an irrigating can, a rubber tube and an adaptor. This is done before the tourniquet is removed. The tourniquet, whether preceded by irrigation or not, is

---

be carried up over thigh and the skin edges protected by it, but for photographic reasons this has not been done. This type of drape allows one to move the limb freely in all directions and aids in lining up fragments when necessary. Note that this is a bloodless, ideal field. Note whiteness of tissue and bone. This is the way a field should look with a well applied tourniquet.

FIG. 12. Same case after release of tourniquet and before closing wound. Bleeders at this time are seized and tied. Contrast with Figure 11.

released at the completion of the operation. Following the release of the tourniquet there is a transitory hyperemia lasting but a few minutes. During this time the bleeding is profuse. We believe this rush of blood is beneficial in washing the wound of accumulated dust and in diminishing the bacterial count. After the hyperemia passes and the bleeding has practically stopped, the wound is inspected for persistent bleeding. These vessels are ligated. The wound is then closed attaching each layer of tissue to the layer underneath to prevent ready formation of hematoma in dead spaces. (Figs. 11 and 12.)

Repeatedly it has been stated that upon the release of a tourniquet the patient not infrequently goes into shock. This we have not experienced although we have looked constantly for it.

#### COMPLICATIONS OF TOURNIQUET APPLICATION

*Tourniquet Blisters and Burns.* These mishaps causing blebs or burns are due solely to lack of care in the application of the tourniquet or in the preparation of the limb at time of surgery.

The blisters are caused either by having the skin bulging through spaces in the Esmarch wraps or wrapping the Esmarch over large wrinkles in the towel. In case of the pneumatic type, blisters are caused by inflating the cuff on a wrinkled surface of toweling or having wrinkles or foreign material on the cuff proper. In case of the blood pressure cuff it is simply applying it without care to see that it lies smoothly on the skin surface.

Burns are caused by careless use of ether, alcohol, and tinctures. These are allowed to drip or run down the limb and to saturate the tourniquet towel, felt, or cuff. Evaporation under a tourniquet is slow and consequently burns develop over the period the tourniquet is applied. (Fig. 10.)

*The Too Tight Tourniquet.* This complication (not including transitory numbness or weakness for a few hours) is almost

exclusive to the upper extremity. The result of this is paralysis. Sensory and motor loss may be present. The sensory loss is usually not as complete as the motor loss and returns much more promptly. Three factors enter into this tragedy: One is applying the constrictor too tight. The second is using the wrong type of tourniquet where pressure cannot be controlled, and the third is applying the constrictor on the arm without regard to anatomical considerations.

*That pressure and pressure alone causes this paralysis in the human would seem to this writer the most logical supposition.* It is hard to understand how local anemia of nerve tissue can cause this paralysis. It is a known fact the nerve paralysis occurs from short pressure phenomena exhibited by the following examples of which there are many more:

1. Wrist drop in so-called honeymoon paralysis. Wrist drop resulting from strapping the arm to the side by a cloth or adhesive binder where a tight band passes across the lower third of the humerus over the radial nerve.

2. In all types of arm paralysis such as sleeping with the arm across a firm support or while under an anesthetic having the arm pressing against an unpadded portion of the table.

3. Foot drop from peroneal pressure resulting from such causes as plaster boots, obstetrical stirrups or at times from crossing one knee over the other.

In tourniquet paralysis, *the paralysis has little relation to the time the tourniquet has been on.* It follows short operations as frequently as long operations. Certainly if anemia of nerve tissue was the cause, we would expect it to follow most long operations for in a well applied tourniquet the anemia is absolute. This, though, is not the case. Nerve paralysis from tourniquet in the human results from pressure of the nerve against bone or resistant tissue caused either by selecting the wrong site for the tourniquet, by applying it far too tightly or using the wrong

type of tourniquet where there is no exact means of estimating the pressure.

#### CASE REPORT

A male, aged twenty-eight years, with tuberculosis of the right wrist was operated upon for wrist fusion under a general anesthetic and pneumatic tourniquet. The field was bloodless throughout the operation which lasted about eighty minutes, sixty minutes of which the tourniquet was in place. Following surgery all motor power and sensation was lost in the fingers and as far up the hand as could be determined with the plaster on. The sensation returned gradually from the hand to the fingers and was normal within four weeks of operation. There was no return of motor power to the fingers until at the eighth week slight flexion of the thumb was noted. Gradually motion in all fingers returned until at the twenty-second week after operation motion was present and active in all the fingers.

Investigation of this accident showed that this pneumatic cuff was one of our extra cuffs that are used for the thigh. It had no gauge attached to it and it had been placed about the middle of the arm and pumped up firmly until in the technician's mind there was no doubt that the pressure was sufficient to prevent leaking.

*Leaky Tourniquet.* This is the most dangerous fault in tourniquet application. In the writer's experience and from what can be gathered out of reports, sufficient emphasis has not been placed on this type of tourniquet accident. In the reports published it is hard to judge what causes the trouble because no reference is made as to the state of the hemostasis obtained. The severe damage that may occur here is permanent and in marked cases that are permanent resembles a Volkmann's ischemic paralysis. As stated before, no tourniquet properly applied has any oozing of blood in the field. The blood that does extrude on cutting the vessels is, or should be, cherry red. In a field where the tourniquet is leaking there is an ooze of blue or blue-black blood and this ooze is continuous. The blood is sponged away but more returns. If when the tissue is incised,

this occurs, the tourniquet should be released immediately and only applied again after at least a ten-minute wait, if at all. This writer has observed a complete Volkmann's type of paralysis of a lower extremity in a Negro boy following the application of such a tourniquet that was left on for ninety minutes. It is this type of tourniquet, in our experience, that is accepted many places as adequate and which accounts for tourniquet pain, sensory and motor disturbances, marked hyperemia and swelling of the limbs after operation. In reviewing cases of gangrene of fingers on which novocaine and rubber band tourniquet were employed no complications have been found where 1 per cent novocaine has been infiltrated just distal to the metacarpalphalangeal joint and proper, absolute tourniquets applied about the finger's base just distal to the infiltrated area. This has been our experience in many finger and toe operations when we used this technic.

The danger of a leaking tourniquet, in this writer's opinion, is that all venous return from the limb is cut off by the tourniquet's pressure but the arterial blood is allowed into the limb. The result is that gradually the capillary beds are completely filled with blood; but since the blood cannot get in the already distended venous system, a pressure in the beds is gradually built up which approaches that on the arterial side. This ultimately bursts the capillaries and the blood is extruded into the tissues causing multiple inter- and intracellular hemorrhages throughout the whole limb below the tourniquet. The immediate reaction is one of inflammation, circulatory spasm, death of tissue, and paralysis which in severe cases is followed by fibrosis and atrophy of the part. All grades of this have been seen by this writer from mild reactions to a Volkmann's type.

#### CASE REPORT

A fifty-four year old woman who had stenosing tenosynovitis of the extensor tendon of

the right thumb was operated under pentothal anesthesia and a tourniquet of the blood pressure cuff type. Before applying the tourniquet the extremity had been drained of blood by the application of an elastic bandage. The cuff had been raised to a pressure of 250 mm. of mercury. This tourniquet had been on twenty minutes before it was viewed by us. When first seen by us the hand and forearm were purple. The veins were distended and the whole hand and forearm were covered by minute punctate skin hemorrhages. The tourniquet was released. Circulation was established for ten minutes. The extremity was then elevated and the tourniquet was reapplied with a pressure of 350 mm. of mercury. The field was opened by a rather long incision. The field was dry and bloodless. Throughout the entire operative area, including the subcutaneous area, tendon sheaths, muscle and even periosteum, innumerable small punctate hemorrhages were present. Dissection was carried over to the radial artery and the radial nerve. The tissues surrounding the artery and nerve exhibited the same findings. When the tendon sheath over the extensor tendon of the thumb was opened, it was edematous and swollen as was expected, but this tissue also exhibited these fine punctate fresh hemorrhages.

The day after operation the patient complained of numbness and tingling in the fingers and an ache in the forearm. The hand was cold, somewhat swollen throughout and the circulation was sluggish. The petechial hemorrhages in the skin were more apparent than the day of operation. All motor and sensory factors were present. Six months later the patient still complained of numbness and tingling in all fingers and swelling of the hand. *Some loss of sensation in all finger tips was present.* This loss of sensation in all finger tips did not appear until about six weeks after operation. This fact, it would seem, is due to fibrosis about and in the nerves due to hemorrhage. No indication of scalenus syndrome was present. No real improvement was noted when last seen eight months after operation.

We have explored forearms that have well developed Volkmann's contractures following elbow fractures and have been impressed with the marked fibrosis of tissue and particularly the tremendous de-

crease in size of the nerves as they enter the affected part of the extremity.

#### TIME AND PRESSURES FOR TOURNIQUETS

The time a tourniquet can remain in place is only judged by the collective experience of many cases in which satisfactory tourniquets have been applied and released with no disturbances. We have many times kept tourniquets on the lower extremity for two hours with no ill effects, but we believe that no more than ninety minutes for the lower extremity should be advised. Usually by this time the field has been well developed and explored and has become familiar to the operator so that the releasing of the tourniquet is no real handicap. In the upper extremity we believe seventy minutes is about as long a time that a tourniquet should remain in place. If, as is often the case, many minutes will be used in completing the meticulous work so often experienced here, it is advised to release the tourniquet every forty minutes, then elevate the limb and re-apply.

The pressures for tourniquet application have been given a great deal of attention by us. Generally 250 mm. of mercury for the arm and 570 mm. of mercury pressure for the lower limb is recommended. We have found these to be entirely inadequate and result in leaking past the tourniquet in so many patients as to cause us to increase our pressures routinely.

For the past five years we have used on the arm a pressure of 350 mm. of mercury as shown on the blood pressure cuff as a routine. This pressure has given excellent tourniquets and no complications. We have kept tourniquets at this pressure on for as long as ninety minutes. In the lower extremity the standard pressure adopted by us has been twenty-two pounds as read on the gauge. These have not leaked while at twenty pounds some of the tourniquets have leaked. No ill effects from this pressure have occurred.

The tissues of children under seven are softer than adults and these take some-

what lower pressures to compress the arteries. These pressures have not been used by us because we wanted to use them, but because after long and careful search for the ideal pressures these have been found to be nearly the ideal in producing uniformly good tourniquets with no ill effects resulting.

It is to be remembered that tourniquets leak when the pressures in the tourniquet are far above that of the patient's arterial pressure as determined by cuff. The object is to obtain a pressure that produces the result without harm. We advocate these pressures because we use them, have been

forced to use them, and in all cases to date, no ill effects have resulted.

#### CONCLUSIONS

A discussion of the tourniquet, its advantages and disadvantages, has been presented. Tourniquet accidents result from careless application of the constrictor and are due to the tourniquet being too tight, too loose, remaining on too long, or applied with no consideration for the anatomy of the part.

A method of tourniquet application is described which, when followed, has given complete satisfaction in actual practice.



*Announcement:* The American Society of Anesthesiologists, Inc., are offering a prize of \$100 for the best original essay, not published previously, on some phase of anesthesiology or on a subject closely related to it. Information concerning the contest may be obtained by writing to either Dr. R. Charles Adams, Chairman, Mayo Clinic, Rochester, Minnesota, or to Dr. McKinnie L. Phelps, 745 Fifth Avenue, New York 22, N.Y.

# NORMAL PHYSIOLOGICAL DOUCHES\*

KARL JOHN KARNAKY, M.D.  
Gynecologist, Jefferson Davis Hospital  
HOUSTON, TEXAS

IN a previous publication<sup>1</sup> it was brought out that many physicians are still prescribing alkaline substances, sodium perborate, borax, sodium bicarbonate, potassium permanganate, magnesium sulfate, and sodium chloride or a combination of these in the treatment of vaginal leukorrhea or as a cleansing douche when

it is scientifically established that the normal hydrogen ion concentration of the adult vagina is markedly acid, 4.0-4.5.

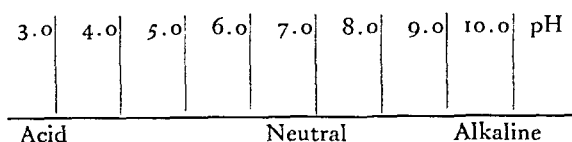


FIG. 1.

Yet I see patients who have been told by their physicians to use sodium bicarbonate, magnesium sulfate, borax, potassium permanganate and others. The following table shows the reaction of various medications used for douches:

When pathological changes occur in the vagina, the hydrogen ion concentration approaches the alkaline side. Then there is, so to speak, a hypo-acidity of the vagina similar to hypochlorhydria of the stomach. Just as one would not prescribe an alkaline preparation for a case of hypochlorhydria, just so in vaginitis, the vagina should be acidified rather than alkalinized. The following diagram illustrates the significance of the symbol "pH." pH 7.0 is the point of neutrality. (Fig. 1.)

The following is a summary of 713 consecutive pH readings done on 163 consecutive gynecological patients coming to the office. This was done with an electro-Beckman pH instrument. (Table II.)

## PHYSIOLOGY OF THE VAGINA

The physiology of the normal vagina should be logically considered before a rational approach to treatment may be undertaken. At the Jefferson Davis Hospital and in private practice we have made an exhaustive study of vaginal hydrogen ion concentration, vaginal epi-

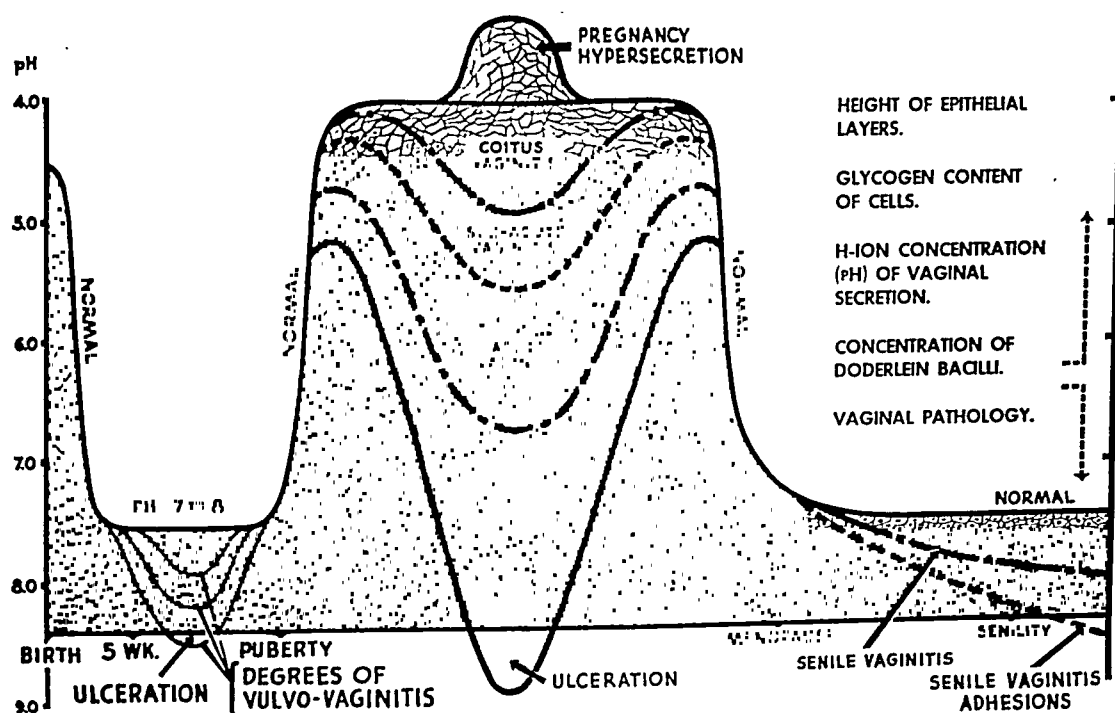
Substance	pH
Vinegar	
4 tablespoonfuls to 1 qt. water.....	3.50
Lactic acid U.S.P.	
1 teaspoonful to 1 qt.....	2.56
1 teaspoonful to 2 qt.....	2.85
Boric acid	
1 tablespoonful to 2 qt.....	6.45
½ saturated solution.....	4.10
Supersaturated solution.....	3.60
Hexylresorcinol.....	3.90
Acetarson.....	3.90
0.1 Normal Solution	
HCl.....	1.00
H <sub>2</sub> SO <sub>4</sub> .....	1.20
Floraquin.....	2.90
Alum.....	3.20
Boric Acid.....	5.20
Caprokol.....	5.90
Glycerin.....	5.50
Alderson.....	6.40
Magnesium sulfate	
1 tablespoonful to 1 qt.....	7.50
2 tablespoonfuls to 1 qt.....	7.40
Sodium Perborate	
1 tablespoonful to 1 qt.....	10.09
2 tablespoonfuls to 1 qt.....	10.13
Iodine	
1 teaspoonful to 1 qt.....	7.50
2 teaspoonfuls to 1 qt.....	7.40
Lugol's solution	
1 tablespoonful to 1 qt.....	5.74
Sodium Chloride	
1 tablespoonful to 1 qt.....	7.90
2 tablespoonfuls to 1 qt.....	7.65
1 cup to a quart.....	7.30
Potassium permanganate.....	7.30
Sodium bicarbonate	
1 teaspoonful to 1 qt.....	8.10
2 teaspoonfuls to 1 qt.....	8.00
Silver picrate.....	5.30
Borax.....	9.20

\* From the Department of Gynecology, Research Division, Jefferson Davis Hospital, Baylor Medical School, Houston, Texas.



thelial cell height, vaginal bacterial flora, glycogen content of the vaginal epithelial cells, and the manner in which glycogen is

The hydrogen ion concentration varies from 3.9 to 5.0. We have tested the vaginal hydrogen ion concentration in over



### LIFE CYCLE OF VAGINAL EPITHELIUM

FIG. 2. The vaginal mucosa of the newborn is thick and contains an abundance of glycogen just like any pregnant woman's vaginal mucosa at term. After about six weeks, due to the loss of estrogenic hormones from the child's circulation, the vaginal mucosa becomes thin and atrophic. At puberty the vaginal mucosa becomes adult in thickness.

broken down to form the normal vaginal acidity. (Fig. 2.)

The reaction of the normal vagina is acid, as tested with nitrazine paper, Heligle, Wulff or the electrometric method.

TABLE II

No. of Patients	No. of pH's	Lowest pH	Highest pH
163	713	3.45	8.15
Average pH			
Posterior Fornix	Anterior Fornix	Left Lateral Wall	Right Lateral Wall
5.244	4.821	4.987	4.902

Average pH for all fornices 4.988.

15,000 patients in our clinic and for practical purposes the normal pH may be considered to be about 4.2. The vaginal hydrogen ion concentration in one series was reported to vary from 4.0 to 5.0. (Fig. 3.)

In view of these observations, it appears logical that all medication should be acidic in property, but precaution should be taken not to produce a concentration so low as to cause irritation to the vaginal mucosa. We have found that a hydrogen ion concentration of 2.9, if not buffered and that of 4.5 to 5.0 if buffered, is most suited for douches, sugars such as glucose, maltose, saccharose, lactose or a combination of the four, are of benefit in the treatment of many vaginal infections because of the acid environment they create.

A stained biopsy of the normal vaginal mucosa shows about forty-five to fifty-five cell layers in height. (Fig. 4.) Sections of

granules in the epithelial layers. (Fig. 5.) The upper layers of the vaginal epithelial cells are well vacuolated and these vacuo-

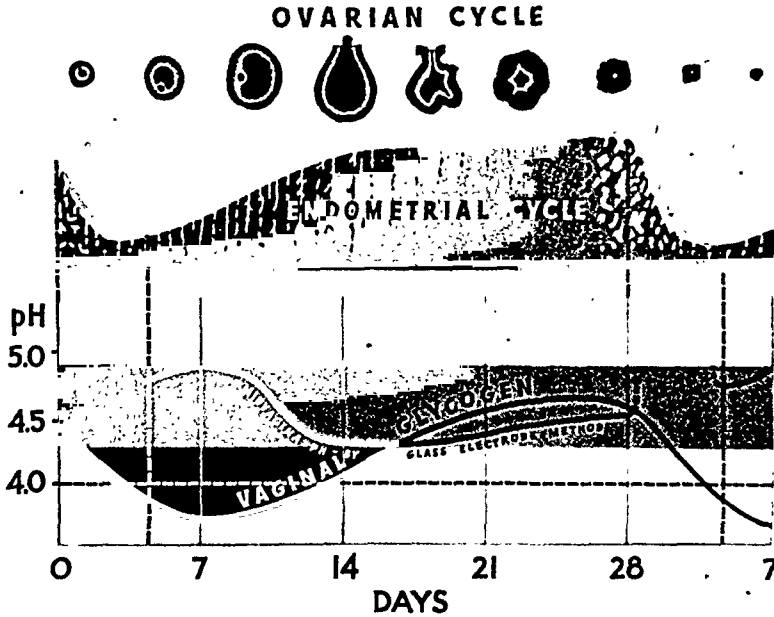


FIG. 3. The ovarian cycle also controls the pH of the vagina, the endometrium and the amount of glycogen in the vaginal mucosa. Estrogens are called the "glycogenic hormone" of the vaginal mucosa. In the endometrium, progesterone is the "glycogenic hormone." Vaginal pH is more acid near the mid-menstrual period in the normal vagina. (Photo obtained through the courtesy of Ortho Products, Linden, New Jersey.)

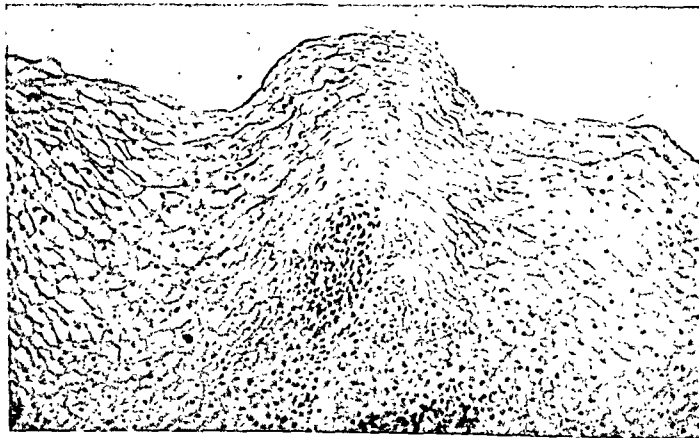


FIG. 4. Normal vaginal mucosa. The vacuolated areas are receptacles for glycogen. The glycogen has been washed out during the preparation of the slide. Almost, if not all the acid of the vagina is produced in the vaginal mucosa because if the vaginal mucosa is made almost absolutely dry by air and cotton drying, the vaginal pH is more acid than before the vagina was made dry.

normal vaginal mucosa stained with Best's carmine stain or other glycogen staining methods, show an abundance of glycogen

lated areas are receptacles for glycogen which is picked up from the blood by the vaginal epithelial cells. The deposition of

glycogen is brought about by estrogenic influences. The glycogen is broken down into glucose and finally into lactic acid

If a smear from an infected or postoperative vagina is made, whether the infection is due to streptococci, *Bacillus coli*,

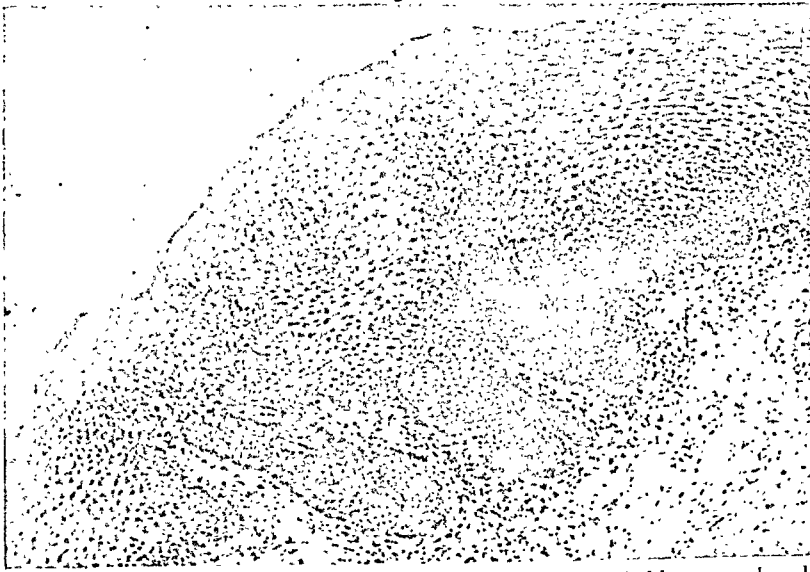


FIG. 5. Normal vaginal mucosa showing glycogen granules. Acids are produced in the vaginal mucosal cells and then pass into the vaginal cavity. Estrogens cause growth and deposition of glycogen in the vaginal mucosa. The glycogen in turn is metabolized into lactic and other organic acids.

in the epithelial cells and in the vagina, which is the normal acid of the vagina. In the vagina this is carried out by enzyme action and the Doederlein bacilli. Other organic acids are also produced.

The application of Lugol's solution to the normal vaginal mucosa produces a deep mahogany color; due to the action of iodine on glycogen, no change in color results; if there is a decrease in glycogen, there is a decrease in the intensity of the mahogany color.

In infections or trauma to the vaginal mucosa, as seen postoperatively, there occurs a depletion or almost complete loss of glycogen with less mahogany color formation and less acid reaction. In these conditions there is a definite decrease in the amount of glycogen stored in the epithelial cells.

A fresh stained smear from a normal vagina shows many thick, rod-like organisms (Doederlein bacilli) and many large clumped epithelial cells with small nuclei. The epithelial cells stain normally. There are few pus cells or none at all. (Fig. 6.)

staphylococcus, diphtheroid or some other organism, few, if any, of these Doederlein bacilli are seen. We also see many shapes, forms and kinds of micro-organisms such as streptococcus, staphylococcus and colon bacillus. The epithelial cells do not take the stain so readily and also are no longer in groups but are broken up into fragments. It may then be said that in an infected vagina there is a mixed vaginal flora with a definite decrease in the number of Doederlein bacilli. (Fig. 7.)

In vaginal infections, there is therefore a state of abnormality in four physiologic elements: (1) hypo-acidity, (2) hypo-glycogen, (3) hypo-epithelium\* and (4) hypo-Doederlein. Hypo-acidity or lack of the normal amount of acid is the most important of these four.

#### ACIDITY, ALKALINITY AND GROWTH OF VAGINAL MICRO-ORGANISMS

To substantiate some of our previous investigations, eight cases of acute vagi-

\*Hypo-epithelium is a decrease in height of vaginal mucosa.

nititis with foul discharge were surveyed in an experiment. The patients were instructed not to take douches and to concentration of 5.5 in two cases, 5.4 in four cases and below 4.5 in all cases. Growths in the controls were most abun-

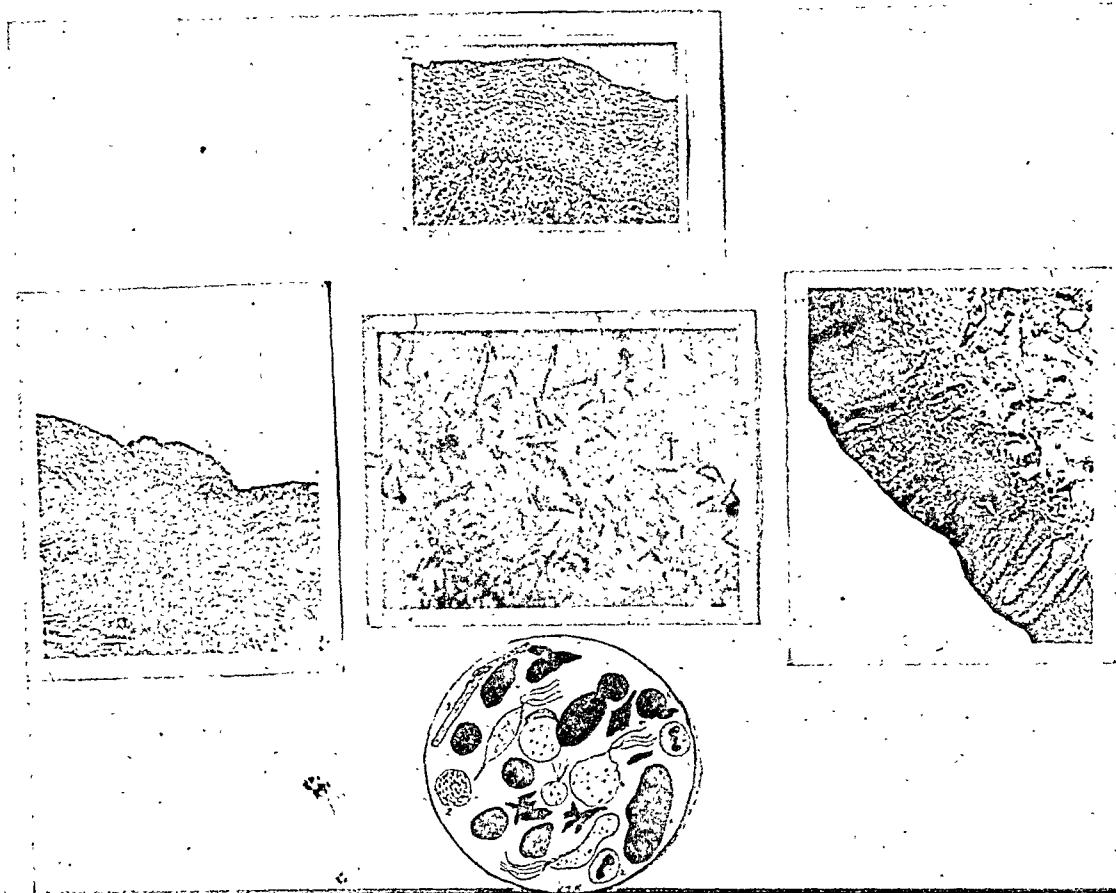


FIG. 6. Upper: Normal vaginal mucosa. middle: Döderlein bacilli from smear taken from vagina of upper picture. Left: Senile vaginal mucosa. Right: One of the small trichomonal ulcers. Lower: A fresh smear taken from the vagina having the trichomonal ulcer. Also shown are the many other bodies that must be differentiated from trichomonas vaginalis. This is the debris that must be dissolved and washed out when douching.

omit coitus. Vaginal treatment was suspended for two weeks. External plain water washes were allowed. By sterile technic, all the vaginal secretion that could be collected from the vagina was placed in 0.5 cc. of warm sterile water in a sterile test tube. From this solution a smear was made on agar of a hydrogen ion concentration of 2.8, 3.6, 4.4, 5.4, 5.5, 6.0, 7.0, 7.2, 7.6, and 8.0.

Bacterial growths were most abundant at a hydrogen ion concentration of 7.6 and 8.0 and as the concentration became more acid, the bacterial growth became less pronounced. There was no growth at the

dant in 7.6 and 8.0. Staphylococcus and colon bacillus did not grow at 5.0 or below.

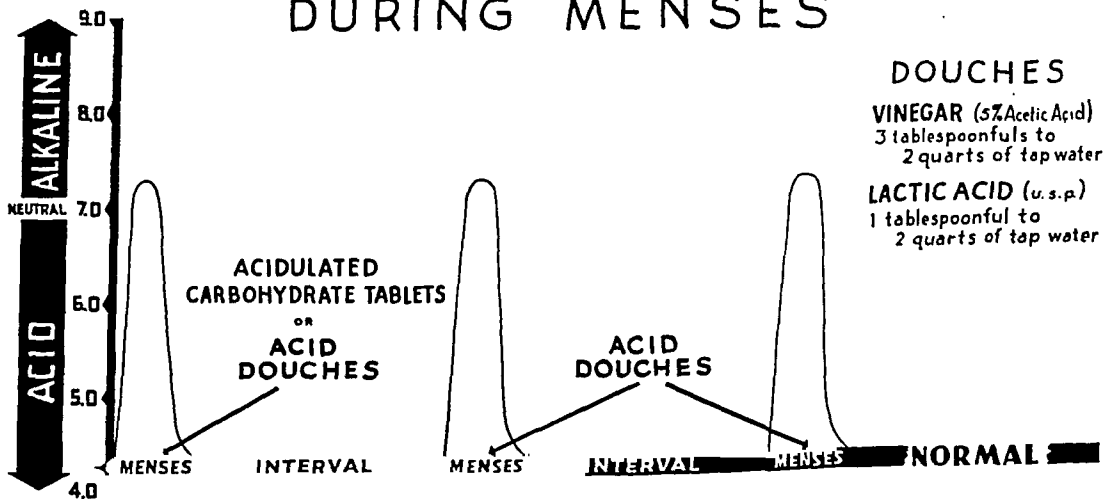
A number of other patients were tested with vaginal jelly adjusted over a hydrogen ion concentration range of 2.0 to 9.0 and the results were similar to those previously obtained.

With these facts in mind, it appears pertinent to suggest that vaginal medication should conform to the normal vaginal acidity and therefore be acid in reaction. In this connection the writer began to study electrometrically the amount of acid commonly used in douches which would produce a concentration of 4.0. A number



FIG. 7. Stained vaginal smear of trichomonas vaginalis. Note the various types of vaginal flora and forms of trichomonads. These micro-organisms are to be killed and washed out when a woman douches. Vinegar, red or white, in warm tap water produces a pH of 2.9 and dissolves these vaginal micro-organisms. Acid douches encourage the growth of normal vaginal bacilli of Döderlein.

## RATIONALE OF ACID DOUCHES DURING MENSES



DUE TO FLOW OF BLOOD DURING MENSES THE VAGINA APPROACHES AN ALKALINE pH AND THUS FAVORS THE GROWTH OF PATHOGENIC ORGANISMS.

FIG. 8.

of drugs used for vaginal infections and douches were tested directly in contact with the trichomonad under the microscope in an effort to correlate the microscopic and clinical results. The findings are recorded in Table III.

favors the growth of trichomonads and other pathogenic organisms. That accounts for the occasional flare-up of trichomonal infestation after the menses. It is due more to the alkalinity of the blood serum than for any other reason; as evidenced

TABLE III

Drug	Amount of Drug	Amount of Water	Microscopic Results	Clinical Results	pH
Sodium perborate.....	3 heaping teaspoonfuls	Quart tap water	No death	Inefficient	10.0
Lorate.....	2 heaping teaspoonfuls	Quart tap water			10.0
Borax.....	3 heaping teaspoonfuls	Quart tap water	No death	Inefficient	9.0
Zonite.....	2 tablespoonfuls	2 quarts tap water			8.84
Sodium bicarbonate.....	3 heaping teaspoonfuls	Quart tap water	No death	Inefficient	8.0
Dilute sodium hydroxide.....		In tap water	No death	Inefficient	8.0
Magnesium sulfate.....	3 heaping teaspoonfuls	Quart tap water	No death	Inefficient	7.5
Sodium chloride.....	1 cup	Quart tap water	Stops motility immediately no death		7.4
Potassium permanganate.....	3 tablets	Quart tap water	Death	Fair	7.3
Boric acid.....	3 heaping teaspoonfuls	Quart tap water	No death	Inefficient	6.1
Bichloride of mercury.....					5.19
Caprokol.....	1 drop	In vaginal smear on slide	No death	Inefficient	5.9
Anayodin.....	8 cc.	In tap water	No death	Inefficient	5.8
Verazepтол.....	1 teaspoonful	Quart tap water	No death	Inefficient	5.8
Lugol's solution.....	2 heaping teaspoonfuls	Quart tap water	Death	Efficient	5.6
Dilute HCL.....		In tap water	Death	Efficient	5.0
Acijel.....	1 drop	In vaginal smear on slide	Death	Efficient	4.5
Acetarstone.....	1 gr.	5 cc. tap water	Death	Efficient	3.9
Alum.....	1 gr.	5 cc. tap water	Death	Efficient, but dries vagina too much	3.6
Vinegar.....	5 tablespoonfuls	2 quarts tap water	Death	Very efficient	2.9
G.C. douche powder.....	3 heaping teaspoonfuls	Quart tap water	Death	Efficient	3.0
Floraquin.....	¼ tablet	5 cc. tap water	Death	Efficient	2.9
Acetylsalicylic acid.....	5 gr.	5 cc. tap water	Death	Death immediately	
Negatan 10%.....	1 cc.	None	Death	Efficient	2.9
				Too caustic	1.2

There is still a question in the mind of the medical profession as to the possible harm that may result from douching during menstruation. In the author's experience there were no ill effects. The patients with vaginitis are advised to douche during menstruation. (Fig. 8.) Those who insist on avoiding the douche during the menses are advised to insert into the vagina two to five acidulated dextrose-lactose tablets. (Fig. 9.) A concentration of pH 7.0-7.4

by the recurrence to trichomonas vaginitis following bleeding in vaginal operations. The reason that trichomonas infestation follows many cases of gonorrhea is that the resulting alkaline secretion (pH 7.2 to 9.0) neutralizes the vaginal acidity, thus favoring the growth of the trichomonads.

Leukorrhea is thought of by the public in general as a disease by itself instead of a symptom and so do not seek the advice of a gynecologist, but resort to self medica-

tion and make use of the popular advertised fluids as a douche. These solutions may do more harm than good as the

tendency of the misinformed patient to use greater concentrations when a leukorrhea is present. This may lead to tissue



Figure 1. Photomicrograph of a fresh smear showing typical *Trichomonas vaginalis*.



Figure 2. An anatomical picture of the cervix showing the entrance of the vagina.

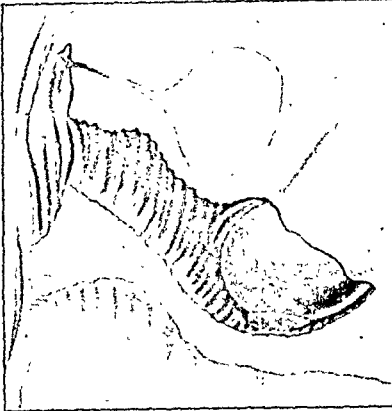


Figure 3. Effect of acid douches on the vaginal pH.



Figure 4. Effect of acid douches on the vaginal pH.

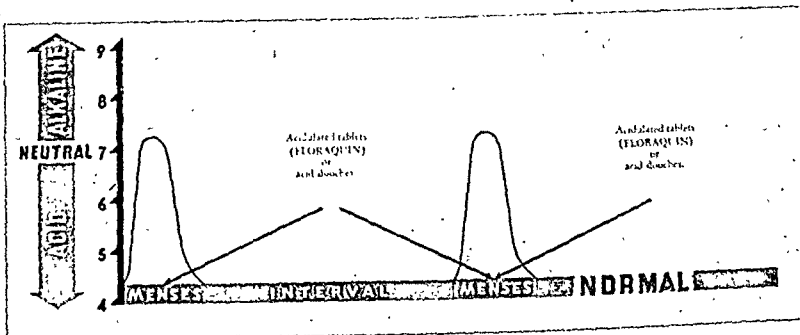


Figure 5. Rationale of use of acid douches or Florquin tablets during menstruation.

The flow of alkaline blood serum over the vaginal mucosa during the period decreases the normal vaginal acidity from pH 4.0 to approach the neutral or alkaline side, thus favoring the growth in a blood serum medium of many pathogenic organisms. By the use of Florquin tablets or frequent acetic acid or lactic acid douches during the period, the desired vaginal acidity may be maintained.

FIG. 9. The rationale of acid tablets or jellies or any acid preparation during and between the menstrual cycle.

hydrogen ion concentration may be on the alkaline side hence non-physiological. Some of these products contain caustic agents.

Since these solutions are also widely used for contraceptive purposes, there is a

irritation and ulceration (ectropion and erosion of the cervix).

#### CONCLUSIONS

1. Acid douches (pH 3.0 to 5.0) should be used instead of alkaline douches, be-

cause with pathologic changes there is a hypo-acidity of the vagina and as these changes increase, the hydrogen ion concentration approaches the alkaline side.

2. Alkaline douches favor the growth of pathogenic organisms.

3. No harm results from suitable warm acid douches during menstruation, when such treatment is indicated.

4. The best douche found in our ten years of research is vinegar (red or white). The patient should be instructed to use five tablespoonfuls of vinegar to the douche bag if there is an acute vaginitis. After two weeks, two to three tablespoonfuls are used instead of five. For an ordinary

cleansing douche use three tablespoons of white or red vinegar to douche bag or can. The patient is instructed to lie down in the bath tub, to hold the lips of the vagina against the nozzle in order that the vagina is distended, to retain the solution for five to ten minutes and to use warm water.

5. Even in sterility cases, soda alkaline douches should not be used.

6. No preparation with a pH of 5.0 or higher as shown in Table III is advocated. In that list there are sixteen out of the twenty-four not advocated.

#### REFERENCE

1. KARNAKY, K. J. Normal physiological douches. *South. M. J.*, 30: 69, 1937.



Profuse leucorrhea, with irritation of the vaginal mucosa and the skin of the vulva, is not uncommon during the weeks or months following confinement. *Trichomonas* infection should be suspected as the cause for this, and examination made microscopically for the organisms.

From "The Management of Obstetric Difficulties" by Paul Titus (C. V. Mosby Company).



# CLINICAL VALUE OF FUNCTIONAL LIVER TESTS

ABRAHAM O. WILENSKY, M.D.

NEW YORK, NEW YORK

**I**NFORMATION concerning the function of the liver can be obtained from two sources: (1) from a study of the normal functions and its variations, and (2) by the use of foreign substances, the variations of whose excretion through the liver furnishes the measure by which the general functional capacity of the liver is to be judged.

The important normal functions which one can investigate include: (1) the metabolism and storage of proteids, carbohydrates (glycogen) and fats, (2) bile formation and excretion, and (3) the formation, presence and variation of the substances involved in blood clotting.

*Metabolism of Proteids.* This seems to be almost entirely a liver function. Normalcy of the protein metabolism has assumed in recent years a paramount position. The establishment of any degree of hypoproteinemia has been shown to be associated with moderately severe and far advanced stages of liver disease and/or injury. The disturbance in the quantitative relationship of serum albumin and globulin has been employed as a diagnostic test also.<sup>2,4,9</sup> Usually the change is a rise in the globulin and a fall in the albumin.

The metabolism of carbohydrate is possessed to some degree by all muscular structures, but the liver is the great storehouse of glycogen. The galactose and levulose tolerance tests are not reliable because too many factors are involved in the mechanism of sugar metabolism.

*Production and Metabolism of Bile.* The bone marrow and the spleen share this function, but again the liver is the important organ. Of the many tests suggested for this investigation, all concern themselves with basic conditions in which there is a deficiency in the production of bile (prehepatic), or, more commonly, obstruc-

tion to the free outflow of the finished product from the liver (posthepatic). The chief tests of this function are the direct and indirect Van den Bergh test and the icteric index (a modification of the Ehrlich-Diazo reaction). Both of these tests can, fortunately, be used quantitatively, and they estimate the amount of bile pigment in the blood stream. A differentiation is possible in the Van den Bergh reaction inasmuch as the test is "direct" in the posthepatic and "indirect" in the prehepatic types of jaundice.

The Fouchet test is similar to the Van den Bergh test. The bilirubin test of von Bergmann and Eilbott is very sensitive utilizing bilirubin itself. There are differences of opinion, however, regarding its reliability.<sup>3,9</sup>

The presence of bilirubin in the urine gives the same information as the Van den Bergh test.

The urobilinogen test is based upon the fact that urobilin, if function is abnormal, is excreted in the urine as urobilinogen. If present in dilutions greater than 1:20, it may be assumed that hepatic damage is extensive.

Estimations of the cholesterolemia have also been used in the jaundice associated with gallstones. The cholesterol ester content as compared with the total cholesterolemia has been found to be lowered in the jaundice resulting from acute hepatic degeneration (prehepatic) as opposed to the jaundice resulting from common duct obstruction (posthepatic).

*Blood Clotting.* Study of the blood clotting function includes the study of prothrombin, thromboplastin, fibrinogen, calcium and vitamin K. The modern tendency<sup>7</sup> is to attribute a large part of the task to the liver. Prothrombin deficiency is usually bound up with a lack of vitamin K.

The disturbance of the blood clotting function is not fundamentally caused by jaundice *per se*, although it is commonly most pronounced then and of great clinical importance. Any grade of hypoprothrombinemia indicates severely damaged liver cells both in the presence and absence of jaundice and in early and late stages of the pathological process.

Other tests include (1) the serum phosphatase test, (2) the Hanger cephalin flocculation test, and (3) the hippuric acid test.

Estimations of the serum phosphatase level are only of value in icteric conditions definitely associated with obstructive jaundice for the reason that similar changes occur in hyperparathyroidism, carcinoma of the prostate, bone tumors, etc.

The Hanger cephalin flocculation test has been used in the various forms of acute hepatitis as opposed to an obstructive jaundice. Both this test and the serum phosphatase test have been used to supplement one another.

The Quick hippuric acid test responds to only one function of the liver and is demonstrable only after very severe disease. Inasmuch as the synthesis of hippuric acid can occur also in the kidney, the test should be checked from that standpoint.

Of all the dye tests of liver function phenoltertraordophthalein has proven to be of greatest use and this of course depends upon its use in radiography. Otherwise none of these dye tests has been of any service clinically.

The total number of available tests of liver function is then considerable. Their complexity indicates that either no one of them has attained any universal degree of approval, or that some of them have only a specific indication which is not always present. To be complete, the obtainable information ought to include: (1) an estimate of whether the disease and/or parenchymal destruction and its consequent physiological disturbance is early or late; (2) whether the disturbance is capable of being corrected; (3) the extent of such

possible recuperation; (4) the potential possibility for further extension of the disease or parenchymal destruction; and (5) whether the pathological process is irreversible.

In practical medicine it has not been possible to attain this objective as they depend on too many variable factors. The more reliable tests are too complicated or expensive for general use, except in a large hospital. Sometimes they are not suited to the particular case in question. They do not always give the desired information and the results are sometimes ambiguous. The success of their clinical integration is very variable. They are, however, somewhat more valuable in enabling us to judge the character and intensity of the underlying pathological process, the severity and extent of the cellular destruction, and the stage of the total illness, but abundant clinical evidence of all this is usually present. The most accurate of them have "reasonable margins of error, and it is possible, because of the enormous reserve capacity of the liver, for a number of things to be seriously wrong while hepatic function remains unimpaired."<sup>1</sup>

Mann<sup>5</sup> has taken advantage of this mechanism and suggests the "straining" of the liver capabilities in order to bring out minor, or less easily demonstrable evidences of change of function. As a matter of fact this is the fundamental mechanism, perhaps, in all methods using foreign substances.

Age is also a very important factor. Estimations of liver function which would be assumed to be abnormal in younger individuals (those under fifty years) are commonly usual in persons above this age period. This is explainable because of the changes in anatomical structure and physiological function which all parenchymatous organs undergo as age advances.

The interpretation of abnormal liver functional tests in medical and surgical patients, with and without clinical symptoms, and without jaundice or other elictable evidences of liver disease, as indicative

of latent, early or occult liver disease, has been presented by a number of clinical observers and some of them have corroborated these assumptions by evidences of change in structural pattern as shown in repeated biopsy or operative specimens and in postmortem examinations; so that no matter how conservative or cautious we may be, these experiences must be accepted. But we must, nevertheless, fully appreciate that these tests have not found disease but only corroborated already existing clinical evidence.

Nevertheless, in practical surgery several tests are beginning to stand out because they indicate certain potential dangers for which we possess therapeutic preventive and/or corrective measures. These are (1) hypoproteinemia, and (2) disturbances of the blood clotting function.

Furthermore, such available information has been somewhat more successful in providing a proper basis for estimating the relative danger of any prospective operation. When such basic information is reliable, and well understood, it becomes of the utmost immediate importance in making one of the indications for the performance of any contemplated operation.

In a much too large proportion of the cases hepatic function is demonstrably maintained fairly normally by compensatory effort. The clinical picture, however, in many of these indicates only too well the severity of the illness and the fact that coma and death may be approaching. These indications are as follows: (1) Severe general symptoms, especially fever and chills; this item is possibly of least importance; (2) excessive anorexia or vomiting; (3) marked shrinkage in the size of the liver; (4) increasing jaundice; (5) any tendency to hemorrhage; (6) sudden diminution of the secretion of urine; (7) azotemia; (8) signs of disturbed cerebral function; in some cases in which operation has been performed additional facts are available; (9) an operatively demonstrated cirrhotic condition of the liver. This indicates far advanced disease and one in which

terminal manifestations may occur at any time. The presence of any degree of ascites only intensifies the significance of such findings. (10) Appearance of postoperative jaundice or any pronounced increase in previously existing jaundice; (11) any renal complication in the presence of a liver lesion is an important test and measure of hepatic function and disease, in properly selected cases. When present, any azotemia becomes not only a measure of the disturbance of renal function, but secondarily, of the preceding hepatic disease. This is the value of any azotemia in liver disease. And in my experience the extent of the azotemia parallels the severity of the liver and of the total disease (hepatorenal syndrome).

#### CONCLUSIONS

Tests of liver function are not essentially diagnostic and can only confirm previously made diagnoses of liver disease. Necessarily, no single isolated test can be of as great clinical importance as a series of repeated tests. When the test is repeated at regular intervals, the series of observations give a picture of the changes which go on in the progression or retrogression of the liver parenchymal lesion. At the same time they furnish information about the potential risk in contemplated operations, and enable fairly accurate prognoses.

At the present writing, the quantitative condition and variation of the proteinemia and the abnormal variations of the blood clotting function give the most important information. Next in order are the tests which measure the degree of jaundice. None of the dye tests are of enough clinical importance except the phenoltetraiodophthalein test and the latter gives its most important information only radiographically of the mechanical conditions governing the excretion of the contents of the gallbladder. In the presence of such basic conditions, clinical assumptions of the pathology and disturbance of function and of the progression or retrogression of the underlying disease must make additional use of other sources of circumstantial evi-

dence and of these the most important are yielded by the kidney because of secondary changes occurring therein (hepatorenal syndrome). And the disturbance in the latter, especially the degree of any accompanying azotemia, can be used as a measure of the anatomical and functional changes in the liver.

## REFERENCES

1. BOYCE, FREDERICK F. and McFETRIDGE, ELIZ. M. Studies of hepatic function by the quick hippuric acid test. 1. Biliary and hepatic disease. *Arch. Surg.*, 37: 401-426, 1938.
2. FOLEY, E., KEETON, R. W., KENDRICK, A. B. and DARLING, D. Alterations in serum proteins as an index of liver failure. *Proc. Soc. Exper. Biol. & Med.* 33: 430, 1935.
3. HARROP, G. A., JR. and BARRON, E. S. G. Excretion of intravenously injected bilirubin as test of liver function. *J. Clin. Invest.*, 9: 577, 1931.
4. KIRK, R. C. The Takata-Ara test and its relation to cirrhosis of the liver. *J. A. M. A.*, 107: 1354, 1936.
5. MANN, F. C. Hepatic physiology and path. from the surgical viewpoint. *Minnesota Med.*, 19: 695, 1936; Hepatic function in relation to hepatic pathology, exper. observations, *Ann. Int. Med.*, 8: 432, 1934.
6. QUICK, A. J. Congugation of benzoic acid with blycine, a test of liver function. *Proc. Soc. Exper. Biol. & Med.*, 29: 12, 1932; Synthesis of hippuric acid. *Am. J. Med. Sc.*, 185: 630, 1933.
7. QUICK, A. J., STANLEY-BROWN, M. and BANCROFT, F. W. Study of the coagulation defect in hemophilia and in jaundice. *Am. J. Med. Sc.*, 190: 501, 1935.
8. QUICK, A. J. Clinical value of the test for hippuric acid in cases of disease of the liver. *Arch. Int. Med.*, 57: 544, 1936.
9. SNELL, A. M. and PLUNKET, J. E. Hippuric acid test for hepatic function; it's relation to other tests in general use. *Am. J. Digest & Nutrition*, 2: 716, 1935.
10. WILENSKY, A. O. Occurence, distribution and pathogenesis of so-called liver death and/or the hepatorenal syndrome. *Arch. Surg.*, 38: 625-691, 1929.
11. WILENSKY, A. O. The danger of procrastination in biliary tract disease until irreversible kidney and liver changes occur. *Am. J. Med. Sc.*, 203: 231-241, 1942.
12. WILENSKY, A. O. Relation of nitrogen bodies of blood to surgical problems in liver and in biliary tract disease. *Arch. Surg.*, 14: 1222-1245, 1927.



---

---

# Case Reports

---

## LIGATION OF THE INFERIOR VENA CAVA FOR PNEUMONIC THROMBOPHLEBITIS\*

HOWARD M. KERN, M.D.

AND

EDGAR BERMAN, M.D.

Member Founders Group, American Board of Surgery

Resident in Surgery, Sinai Hospital

BALTIMORE, MARYLAND

MAJOR veins of the lower extremities and pelvis are now exposed and ligated much more frequently than was the case some few years ago. Resection of the internal saphenous vein at the fossa ovalis in the treatment of varicose veins and superficial thrombophlebitis has become routine. Ligation of the femoral and iliac veins to prevent embolism from thrombosis of the deep veins of the extremities has in recent years saved many lives from a fatal pulmonary accident.

Familiar as we were with these procedures, it was surprising to learn that ligation of the inferior vena cava for thrombosis had been advocated at least a half a century ago.

With but few exceptions, the early surgery done upon the vena cava resulted from accidental opening of the vessel in the course of a difficult operation upon the kidney or a tumor in the region of the kidney. At times, the caval rent could be sutured or clamped and upon other occasions, the damage was so great that the vessel had to be ligated. Kocher, in 1883, was credited with having performed the first total ligation. It was purely accidental and discovered at autopsy following an operation for retroperitoneal metastases resulting from carcinoma of the testis. Billroth, in 1885, reported a case which ended fatally. Bottini, in 1905, reported a successful resection of the inferior vena cava performed during the removal of a sarcoma. There are numerous other reports

of vena cava ligation in the literature, practically all of them associated with kidney operations. In 1905, Goldman made a careful investigation regarding ligation of the inferior vena cava in connection with special cases. He referred to the excellent results obtained by Houzel, Heresco, Albrarran, Bottini and Hartman who performed ligations following serious rents in the vessel. Lindner, according to Kocher, regarded the vena cava in the same light as all other large veins in the body, i.e., not only could it be ligated but could also be excised when adherent to tumors or thrombosed.

Gosset and Lécenè proved experimentally that ligation of the cava above the renal vessels was always fatal while Purpura (1899) found that death need not occur if a collateral circulation had been established by pre-existing stenosis of the vena cava.

Goldman quotes 112 cases of thrombosis of the vena cava observed by Vimont. In these, the edema and ascites was more marked than after complete ligation of the vessel. Injection experiments by Lappe, Poirer, Goldman and others have shown that after ligature, the blood is returned to the heart without difficulty and that of the numerous auxiliary anastomoses in existence, the veins in and about the spinal canal, in the groin and the azygos veins are the principal channels by which it is effected. More recently, Pfaff reported a successful ligation which was necessi-

\* From the Department of Surgery, Sinai Hospital, Baltimore, Md.

tated by rupture which occurred during the removal of a retroperitoneal cyst. Wakefield and Mayo carefully reviewed nineteen cases of ligation of the lower one-third of the vena cava, collected from the early literature. Fifteen of the patients survived. Five had persistent edema of the lower extremities, the edema of three was transitory, and the remaining six had none. None of these patients had visible collateral circulation. They also studied fourteen cases in which a postmortem or anatomic diagnosis had been made in the clinic. Most of these patients had been operated upon and were well along in their convalescence before death occurred. The outstanding sign in this group was the sudden onset of bilateral edema due to vena cava thrombosis. As a result of their investigation, they concluded that, (1) the vena cava may be safely ligated and that an adequate collateral circulation will be established; (2) should it be possible to make a diagnosis, of ascending thrombosis of either one or both iliac veins, the ligation of the vena cava below the renal veins may well be a life-saving measure.

Walters and Priestly reported four successive cases of surgery upon the inferior vena cava. Hyman and Leiter reported eleven cases with three postoperative deaths. In four of these cases, the vena cava was accidentally injured. In seven cases the surgery was deliberate.

Pleasants, in 1911, made a most extensive analytical study of 314 cases of inferior vena cava obstruction and found that the signs and symptoms are dependent upon the mechanical obstruction *per se* and upon the condition which gives rise to the obstruction. Other important considerations are the position, the extent, the rapidity and completeness of the obstruction. Obstruction of the lower third of the vena cava, even in sudden occlusion, will frequently not give edema. Its presence is associated with the blockage of the iliac veins. Edema of the abdominal wall is rare. Albuminuria is rare. In obstruc-

tion in the middle third, sudden occlusions are invariably fatal. In gradual occlusion, edema followed by superficial collateral



FIG. 1. Photograph taken four days postoperatively showing marked edema of the genitalia and thighs.

vessel formation occurs in all cases. Albuminuria is generally present at first and may be associated with other disturbances of kidney function. In obstruction of the upper third, sudden occlusions are fatal. In cases of gradual occlusion, a "Caput Medusae" is apt to occur. Otherwise, the picture is the same as that seen in middle third obstruction. Obstruction of the hepatic vein is associated with dysfunction of the kidneys, liver and other abdominal organs. Albuminuria, jaundice and ascites is frequently present. Diarrhea and vomiting may occur.

#### CASE REPORT

C. K., a twenty-nine year old, white male, was admitted to the Sinai Hospital January 5, 1944. He was seen by a physician eight days prior to admission for the treatment of a cold of one week's duration. On the evening of that day, the patient was seized with a shaking chill

which lasted about one hour. The next day, the patient stated his chest became a little sore on the left side anteriorly. He also developed a cold

lips. The trachea was deviated to the right. There was fixation of the left chest which was dull in the upper portion and flat in the lower.

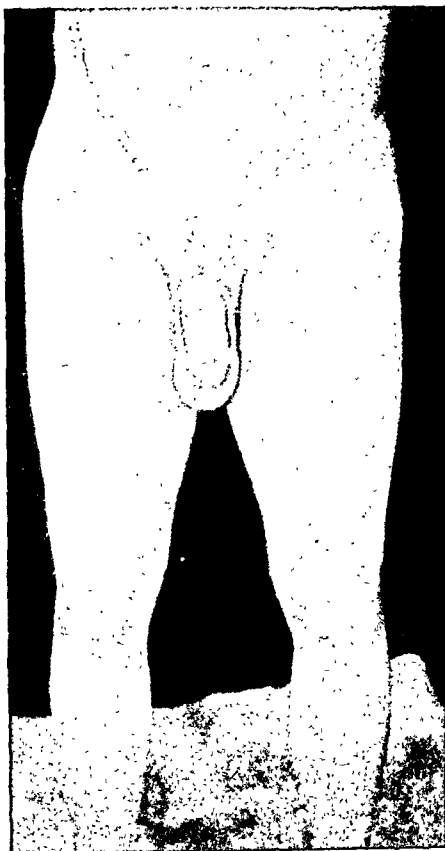


FIG. 2.

FIG. 2. Photograph taken just before patient was discharged from the hospital, showing the abdominal incision and the complete disappearance of the edema while the patient was in bed.

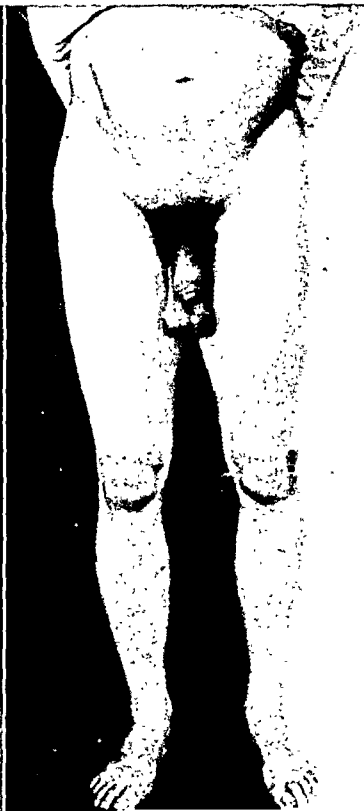


FIG. 3.

FIG. 3. Photograph taken August 22, 1944, about five months postoperatively. Note equal size of legs and absence of edema.

and brought up what he described as blood streaked, pink sputum. The patient was also febrile. The patient says that he was seen by his physician six days ago and sulfa drugs were prescribed. He took eight tablets to start and was told to take two every two hours. The patient stated that his condition did not improve and that he spent many restless nights. He denied tuberculosis in himself or family and stated that at one time he was suspected of having "sugar in his blood."

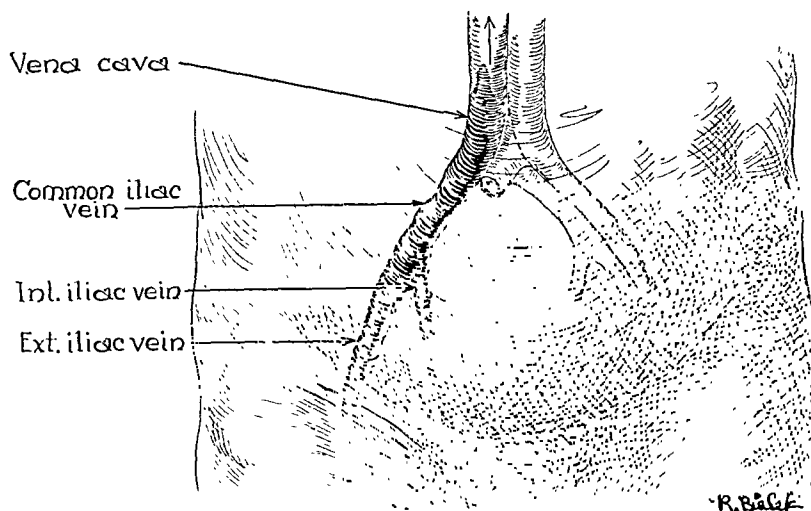
Physical examination revealed the following: Temperature 102.8°F., pulse 130, respirations 40, blood pressure 125/75. He was a well developed and nourished young male who appeared acutely ill. He was dyspneic, cyanotic, and very lethargic. Herpes were present on the

Breath sounds were diminished to absent with friction rub in the left axilla and base. There was no edema of the extremities. There was a mass in the right upper quadrant of the abdomen which was thought to be liver. The urine was loaded with sulfa crystals. No rbs; hemoglobin 11.5, white blood cells 38,950; sulfadiazine level 8.1; sugar .100; sputum type 2 pneumococcus.

The patient was put on sulfapyridine, Gm. 1 every four hours but he still continued to run a low-grade fever of about 100°F. maximum until January 13th; at this time, his temperature went up to 102.5°F. and he ran a septic temperature up to 103°F. every day. He was then placed on sulfathiazole, Gm. 1, every four hours, with no results. On January 26th,

he began to run a more spiking, remittent fever and all sulfa drugs were discontinued. Two days later his white count was still 18,000

104°F. with a pulse of 130. He had another lumbar ganglion injection on the thirteenth with no results. At this time, the patient had a



Schematic drawing showing thrombosed veins found at operation

FIG. 4.

with 89 per cent polymorphonuclears. On January 31st, his blood culture was positive for type II pneumococci. At this time, he showed evidence, both clinically and by x-ray, of pneumonia on the right side with an encapsulated empyema between the middle and lower right lobes with some free effusion at the base. His left side was clear. His chest was tapped with the removal of 20 to 30 cc. of clear yellow fluid containing 800 cells which was negative for pneumococci. He was still running a low-grade elevation. On February 8th, his sputum and blood culture were still positive for pneumococci type II.

On the following day, the patient had some discomfort in the right leg and on examination, it was found to be cyanotic, edematous and cold. The arterial pulses were good, bilaterally. There was no calf pain on dorsal flexion of the foot. The diagnosis at this time was iliac thrombophlebitis, right. A paravertebral injection of 25 cc. of 1 per cent novocaine in the second and third lumbar interspaces was given. This gave him some relief from pain. He was placed back on sulfadiazine Gm. 1, every four hours, and on February 12th, was given dicumarol, mg. 100 a day. The prothrombin time, however, did not change, but remained normal. The edema persisted. At this time, his temperature began to spike to

chill lasting for five minutes. The right leg was tremendously edematous, tense and cyanotic. The edema spread up on the abdominal wall. The penis and the scrotum were markedly swollen. The left leg appeared to be normal. Blood cultures were taken which were positive for type II pneumococci. It was then decided that the patient had a suppurative thrombophlebitis in the right iliac vein and was throwing off septic emboli. It was decided to operate at this time and to tie off the vein above the thrombus.

On February 15th, the patient was taken to the operating room. Under spinal anesthesia a high McBurney incision was made. The aponeurosis of the external oblique was incised in the line of its fibers. The internal oblique and transversalis muscles were spread apart and then incised in the line of the incision. The peritoneum was bluntly dissected medially and posteriorly and packed off, exposing the right common iliac vessels and the inferior vena cava. On going through these tissues, to expose the vessels, there was much edema in every layer. The right common iliac vein and the lower portion of the inferior vena cava were found to be surrounded by a fibrinous exudate and these structures appeared friable. The vena cava had a pallid appearance. The right common iliac vein was palpated and was



felt to be solid, with a thrombus. This thrombus extended up for about 5 cm. into the right side of the inferior vena cava and tapered off. The left portion of the lumen was patent. At the point where it was thought that the thrombus terminated the inferior vena cava was dissected from the vertebra in its entire circumference, a suture of kangaroo tendon was placed around the inferior vena cava just proximal to this ligature and tied. There was very little bleeding encountered. The peritoneum was allowed to fall back in place. The musculature was closed with interrupted No. 1 chromic catgut sutures, the fascia with interrupted No. 1 chromic catgut and the skin with continuous black silk. The patient returned to the ward in good condition. He was given a transfusion of 500 cc. of blood.

Postoperatively 100,000 units of penicillin were given daily for eight days. The administration was followed by giant hives. The blood cultures remained positive and the maximum temperature 103°F. until February 25, 1944; (eight days postoperatively) when the temperature fell to normal and the blood cultures became sterile.

On the day following operation, the edema of the right lower extremity and the genitalia was increased. On the third day, the left lower extremity began to swell and the right subside, indicating that the collateral circulation had begun to function on the right. There was evidence of fluid in the abdomen; the abdominal wall up to the costal margin was edematous and the genitalia appeared a little less swollen. On March 1st, sixteen days postoperatively, all of the edema had subsided. The legs and thighs were tightly bandaged with elastoplast and the patient was allowed out of bed on March 3rd. He continued to run an afebrile course and was discharged from the hospital on March 22, 1944.

Since the patient lived some distance from the hospital, he could not be contacted except through his family physician. He stated that for the first two months the patient had a moderate amount of edema of the thighs and legs when on his feet. He was fitted with a pair of full length stockings which he has worn ever since and now, about four months postoperatively, has been able to return to his occupation as a policeman. He reported to the hospital on August 19th for examination and photographs.

Upon close questioning he stated that he did not wear his stockings every day and he noticed no difference in the size of his legs and feet when he left off the stockings, however, he did get tired in his legs at the end of the day.

Upon examination the extremities were equal in circumference at all levels, there was no pitting edema and no cyanosis of the legs or feet. There was no edema of the penis or scrotum. There was also no evidence of varices on the abdominal wall or extremities.

#### SUMMARY AND CONCLUSION

A case is presented of a twenty-nine year old male who developed empyema, septicemia, femoro-iliac and inferior vena cava thrombophlebitis following lobar pneumonia due to pneumococcus type 11. The sulfa drugs, pyradine, thiazole, and diazine proved ineffectual. The blood cultures remained positive in spite of their early and intensive administration. Dicumarol was used but was of doubtful value in limiting the thrombotic process which was the source that continually fed the blood stream with organisms. The patient was cured by the combined procedure of ligature of the vena cava above the thrombus and the administration of penicillin. Which one of these procedures played the major rôle in the patient's recovery is impossible to say. Cases of thrombophlebitis elsewhere in the body associated with septicemia have been reported as cured by the use of penicillin alone. However, we feel justified in stating that the convalescence was very definitely shortened by the surgical intervention, and the danger of embolism, minor or fatal, was eliminated.

Ligature of the vena cava is a relatively simple procedure and can be done without shock to the ill patient when the approach to the vessel is through the retroperitoneal route. The edema of the affected leg will clear more quickly and the swelling of the unaffected leg will not be alarming or disabling and will disappear within two to three months time following operation.

## REFERENCES

- COLLINS, C. G., JONES, J. R. and NELSON, E. W. Treatment of pelvic thrombophlebitis, ligation of inferior vena cava and ovarian veins; preliminary report. *New Orleans M. & S. J.*, 95: 314-329, 1943.
- DEROW, H. A., SCHLESINGER, M. J. and SAVITZ, H. A. Chronic progressive occlusion of inferior vena cava. *Arch. Int. Med.*, 63: 626, 1939.
- GOLDMAN. *Beitr. z. klin. Chir.*, vol. 47, 1905.
- HYMAN, A. and LEITER, H. E. Surgery of inferior vena cava in urologic conditions. *J. Urol.*, 45: 813-826, 1941.
- KOCHER, T. Text Book of Operative Surgery, Vol. T; p. 162. New York, 1911. Macmillan Co.
- PFAFF, O. G. Ligation of inferior vena cava. *Am. J. Obst. & Gynec.*, 11: 660, 1926.
- PLEASANTS, J. H. Obstruction of inferior vena cava—report of 8 cases. *Johns Hopkins Hosp. Rep.*, 16: 363, 1911.
- VIMONT. Contribution à l'étude des oblitérations de la veine cave inférieure. *Par.*, p. 122-125, 1890.
- WAKEFIELD, E. G. and MAYO, C. W. Obstruction of vena cava distal to renal veins. *J. Missouri M. A.*, 31: 92-96, 1934.
- WALTERS, W. and PRIESTLY, J. Surgery of inferior vena cava, clinical and experimental studies. *Am. J. Surg.*, 99: 167-177, 1934.
- WEBER, F. P., RAST H. and WENDT, L. Thrombosis of inferior vena cava, prognosis. *Med. Press*, 196: 262-268, 1938.
- WHITTENBERGER, J. L. and HUGGERIS, C. Ligation of inferior vena cava. *Arch. Surg.*, 41: 1334-1343, 1940.



When veins are small or there is a possibility of the needle within the vein becoming displaced, transfusion and intravenous infusion should unquestionably be conducted through a tied-in cannula. This does not imply that venipuncture has to be relegated to an insignificant backwater.

From "Surgery of Modern Warfare" edited by Hamilton Bailey (The Williams and Wilkins Company).

# DOUBLE UTERUS

JOHN J. VALLONE, M.D.

Assistant Visiting Surgeon, St. Joseph's Hospital

PROVIDENCE, RHODE ISLAND

**B**Y uterus duplex separatus and uterus didelphys is meant a double uterus.

This is, of course, a congenital malformation due to a non-union of the Mullerian ducts. In uterus duplex there is not only a complete separation of the uterine body but also of the cervix. Each body has a single tube, ovary, round and broad ligament. In other words each uterus is complete with the exception of having only one tube, ovary, broad and round ligament. Both uteri may open into the same vagina or each uterus may have its own separate vaginal orifice, resulting in a double vagina. Each uterus may attain a fairly normal development and each function naturally, or one may be only partially developed and deformed, i.e., imperforate. When this occurs and menstruation takes place the flow may be retained in the uterus (hematometra), or in the tubes (hematosalpinx), or in an occluded vagina (hematocolpas). When both uteri are fully developed, a double pregnancy may exist in one uterus or a single pregnancy may take place in each uterus at the same or at different times. Menstruation may take place every two weeks, every month or every two months. The menstrual flow may come from both uteri the same month without any coincidence of dates. When both uteri function normally along with two cervices and two vaginas, patients are usually unaware that they possess a double set of reproductive organs.

A double uterus is quite commonly associated with an anomalous development of neighboring organs, such as, the urinary and fecal tract.

In case of double uterus as has been previously stated, there may be one or a double vagina. When a double vagina is present both sides may be fully developed

or one side may be only partially formed resulting in a blind pouch lacking external opening. Defects of the vagina are deviated into two groups: those involving the upper one-third and those relative to the lower two-thirds. The upper third defects are usually associated with Mullerian duct malformations, such as, double uterus, etc., while those of the lower two-thirds are usually aligned with malformations of the external genitalia, rectum, or urethra. This rule, however, does not always run true to form since the vagina may be divided in its whole length with malformations of the uterus.

## CASE REPORT

Mrs. L. M., a white female, age forty-two, was admitted to St. Joseph's Hospital on October 30, 1944, complaining of a mass in the lower abdomen.

The family history and past history were not remarkable other than the patient had a full term pregnancy eighteen years before with an uneventful delivery. She remembers menstruating three or four times during the pregnancy. There was no history of any other pregnancy or miscarriage. The patient stated that she began menstruating at the age of fourteen. Her periods had always been irregular, sometimes occurring every two weeks. The duration and amount were regular, however.

About nine months before admission the patient began to notice an enlargement of the abdomen. The pelvic mass increased in size each month so that the patient suspected pregnancy despite the fact that she menstruated every month with spotting in between periods. She remembered menstruating during her last pregnancy. Her family physician decided that the increase in size of the abdomen was not in proper proportion to the duration of the suspected pregnancy. After obtaining a negative Aschheim-Zondek test and a negative

x-ray for pregnancy, a diagnosis of uterine fibroids was made.

A septum was felt in the upper one-third of

vesicorectal ligament. This pelvic arrangement reminded me of a  $V_8$  motor. The left round ligament was sewed into the left cervical stump

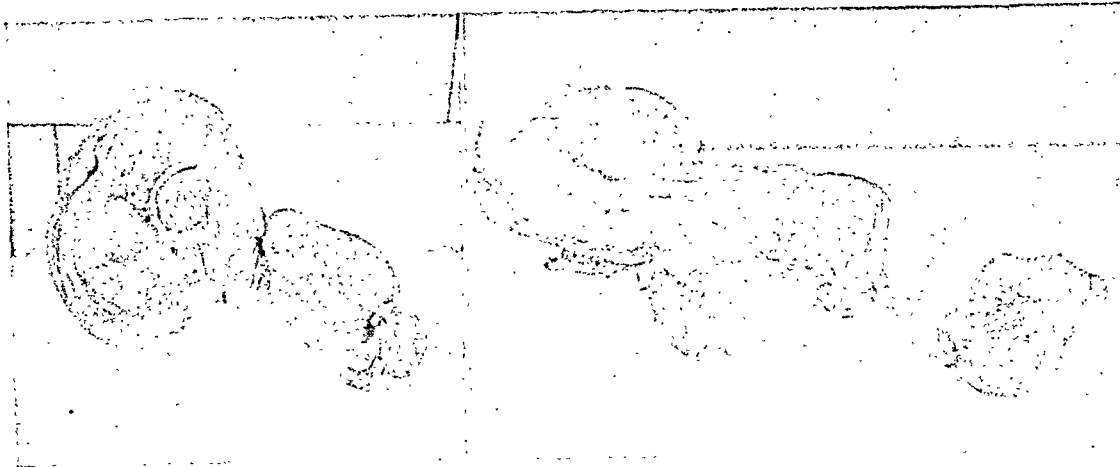


FIG. 1.

FIG. 1. Shows relative position of both uteri in the pelvis.

FIG. 2.

FIG. 2. Both uteri were cut longitudinally to show that each had a distinct uterine cavity.

the vagina. Upon inserting a speculum two distinct and separate cervixes were seen. The left cervix was slightly lacerated, evidently from the delivery eighteen years ago. The right cervix appeared virginal. On bimanual examination a hard globular mass was felt occupying the pelvis. This was about the size of a volley ball. The fundus of the tumor extended to about two inches below the umbilicus. To the left and below the tumor mass was palpated what appeared to be the uterus with several small fibroids projecting from the body.

The abdomen was opened through the usual type of incision and the large pelvic tumor was found to have only one tube, ovary, round and broad ligament, laterally. Underneath and to the right another uterus was found also possessing one tube, ovary, round and broad ligament, laterally. Between both uteri was a well developed large ligament bisecting the pelvis into a right and left half. Each uterus occupied its respective pelvic half. The bladder was not attached to the anterior surface of either uterus as is usually the case, but was suspended underneath his vesicorectal ligament anteriorly, while posteriorly the ligament suspended the rectum. No uterosacral ligament was found. Evidently this vesicorectal ligament had displaced the uterosacral ligament. A subtotal hysterectomy was done on both sides at the level of the internal os. Two cervical stumps were clearly visible, one on each side of the

while the same procedure was carried out on the other side uniting the right round ligament with the corresponding cervical stump. Both areas were then peritonealized in the usual manner.

Following the operation both uteri were cut transversely and as the photographs show each uterus had a distinct uterine cavity and each was completely developed, excepting that both uteri had only one tube, ovary, round and broad ligament.

The pathological report given by Dr. James Hamilton, revealed the following: Anatomical: Specimen consists of two uteri, amputated at the level of the internal os. One is irregular in shape, measuring 15 by 13 by 12 cm. There are two definite encapsulated fibroids protruding from the uterine wall, one measuring 10 cm. and the other 9 cm. Stretched on one surface of the fibroid is a uterine cavity 7 cm. in length. The endometrium is pale, thick and edematous. Several small fibroids surround the endometrial canal. On the surface is an ovary measuring 4 by 2.5 cm. by 2 cm. It is fibrotic and cystic and contains a corpus luteum. The tube measures 7 by .8 cm. It is fimbriated and patent and appears congested. Fibroids are encapsulated and watered-silk in appearance. There is a second uterus, irregular in shape, measuring 9 by 7 by 4.5 cm. On section it is made up of multiple fibroids, varying in size from 1 to 3 cm. in diameter. It has been amputated at the level

of the internal os. The uterine wall measures 2 cm., is uniformly fibrotic, and multiple fibroids are scattered throughout. Stretched over one fibroid is a uterine cavity 2 cm. The endometrium is pale and edematous. Attached to the uterus is a tube 7 by 8 cm., fimbriated and patent. The tube is congested. The ovary measures 4 by 2.5 by 2 cm. It is fibrotic and cystic. There is also a linear piece of skin, subcutaneous tissue and fat, measuring 12 by 1 cm. A scar is seen on the surface.

Diagnosis: Double uterus; multiple fibroids of each uterus. Hyperplasia of endometrium with papillation of endometrial ducts; endometrium infiltrated with leucocytes, plasma and round cells; fibrotic and cystic oophoritis; chronic salpingitis with dilatation and congestion of serosal vessel of tubes.

#### CONCLUSION

Apart from the pelvic malformation of double uterus, cervix and division of the

upper one-third of the vagina the chief points of interest in my opinion are: the unusual division of the pelvis into a symmetrical right and left half by the vesicorectal ligament, and the unusual attachments of the bladder and rectum to this ligament. This ligament originated about one inch below the symphysis running posteriorly and seemed to fuse with the rectum. As has been previously stated the ligament suspended the bladder anteriorly and the rectum posteriorly. This ligament was well developed and was the size of a collapsed segment of small bowel.

#### REFERENCES

1. ANSPACH, B. M. Dev. Anomalies gen. organs. *Anspach Gynecology*, 4: 15, 16, 17, 18, 1929.
2. BLAND, P. B. and FIRST, A. Uterus malformations. *Cyclopedia Med.*, 12: 707, 708, 709, 710, 1937.
3. WARTON, L. R. Cong. Defects of Uterus and Vagina. *Dean Lewis Surgery*, 10: 40, 41, 42, 43, 44, 1930.



# ISOLATED MYELOMA IN A FOURTEEN YEAR OLD BOY

JUSTUS KAUFMAN, M.D.

Assistant Surgeon, City and Gouverneur Hospitals  
NEW YORK, NEW YORK

THE case to be described is that of a fourteen year old boy with an isolated myeloma of the skull treated successfully by a combination of surgery and x-ray therapy. This patient is of particular interest for the following reasons: (1) His youth; (2) the unusual family history; (3) the nature of the lesion, and (4) the excellent end result.

Myeloma is a tumor of bone marrow. It may manifest itself as a single lesion or as multiple lesions. At the other extreme, there may be no gross evidence of bone destruction but rather a generalized hyperplasia of the marrow alone. This would be more of the nature of a myelomatosis, this term signifying a systemic disease. There may also be a combination of this unique hyperplastic marrow and isolated destructive bone lesions.

Myeloma is a relatively rare disease. Symmers and Vance<sup>1</sup> found three cases among 4,000 autopsies at Bellevue Hospital while four cases were found among 9,000 autopsies at Johns Hopkins Hospital. Geschickter and Copeland<sup>2</sup> claim that myeloma occurs in .03 per cent of all types of malignancy and in 3 per cent of bone sarcomas. With reference to the cases of isolated myeloma, Paul and Pohle<sup>3</sup> reviewed the forty-one published cases and added four of their own.

About 80 per cent of all cases of myeloma occur between the ages of forty to seventy. However, Haberfeld and Lordy<sup>4</sup> recorded myeloma in a patient twenty-two years of age. Williams, Ritche and Tettersington describe a probable multiple myeloma in a patient ten years of age. Bertrand<sup>5</sup> published a case of multiple myeloma in an eight year old boy. The case to be described is one of the youngest patients on record with an isolated myeloma.

## CASE REPORTS

The patient, was a fourteen year old male, whose chief complaint on October 19, 1940, was pain in the right occipital region and the presence of a mass at this site which had increased suddenly in size. The pain was of two weeks' duration. It was persistent and localized to one small area. Pressure over this area aggravated the pain.

Past illnesses were negligible with the exception of a severe case of trench mouth which had occurred in July, 1940. This was three months prior to the present illness. The condition was of sufficient severity to require the patient to remain in bed for one week.

The family history was very interesting. Two years previously, in 1938, the patient's aunt died as a result of carcinoma of the breast with osseous metastases. The son of this woman, that is the patient's first cousin, died in 1939 with acute myelogenous leukemia (at the age of 12). The patient's older brother had acute rheumatic fever.

General examination revealed a robust, well nourished, fourteen year old male. The only abnormal findings were directed to the local lesion. There was a cystic mass  $\frac{3}{4}$  inch in diameter over the right occipital bone. It was not freely movable and was tender to palpation.

X-ray of the skull revealed an area of bone rarefaction about the size of a nickel in the right occipital region. This area of osseous destruction had a characteristic punched out appearance. No other lesions were found in the skull. Complete x-ray of the skeleton did not disclose any further disorder.

Red blood count, white blood count and sternal marrow (obtained by aspiration) showed no abnormalities. There was no Bence-Jones albumen in the urine. The basal metabolism was -18 per cent.

Under local anesthesia, the periosteum was incised and a highly vascular cystic mass was removed. A defect was found to extend through both tables of the skull at the base of

which was the dura. As much tumor as possible was removed and the edges of the bone were curetted.

At low magnification there is an impression of uniformity, but higher magnification discloses a moderate pleomorphism. Cells with multiple



FIG. 1. Preoperative x-ray showing characteristic punched out defect in occipital region.

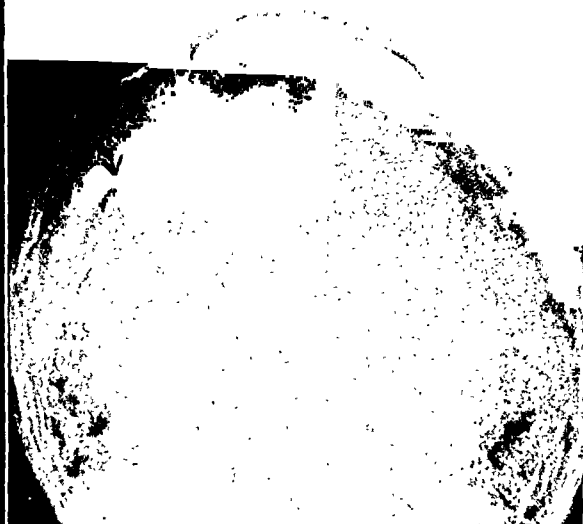


FIG. 2. Occipital view showing characteristic pre-operative skull defect.

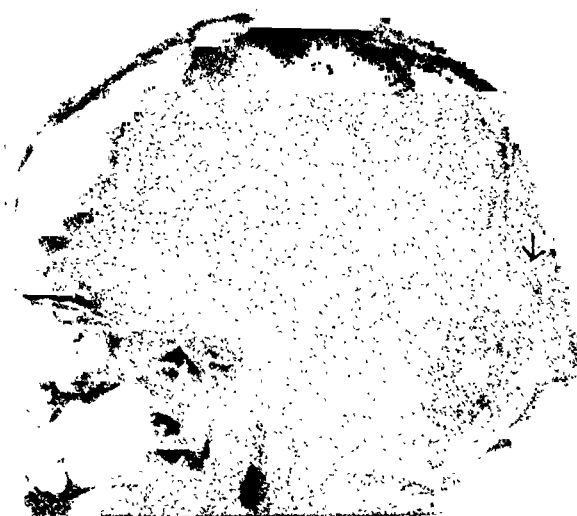


FIG. 3. Four year follow-up, showing defect in skull almost completely filled with bone.

The tumor mass was submitted to Dr. Angelo Sala for histological study. His report is as follows: "The histological appearance is that of a markedly cellular tumor with no intercellular substance; the cells, however, are sharply outlined. Some are rounded; others polygonal; the nuclei are usually but not always eccentric.

nuclei are occasionally encountered. The histological picture is consistent with the diagnosis of myelomas."

One week after surgical removal of the tumor, the patient was referred to Dr. Lewis J. Friedman for postoperative x-ray therapy. A total of 1,755 roentgen units were directed

through a small portal to the right occipital region in fractional doses from October 28, 1940, to November 30, 1940. The factors were 200 K.V., 6 m.a., 1 mm. cu. filter, 60 cm. distance.

Following x-ray therapy, complete epilation occurred. The patient was subsequently observed at six-month intervals and has been perfectly well to the present time. The area of epilation is covered by a growth of new hair and x-rays of the skull taken in April, 1944, show the area of defect in the skull almost completely replaced by bone. The patient was seen by me in August, 1944, and was perfectly well in every respect.

An interesting speculation in this case was made by the late Dr. James Ewing who, in consultation, saw this patient and the histological section. After confirming the diagnosis of myeloma, he suggested that the severe trench mouth infection three months previously might have been an exciting factor in the production of the tumor.

In retrospect, the sudden increase in the size of the tumor mass, as noticed by the patient, was probably due to the intraosseous hemorrhage, the result of bone erosion.

The observation of an isolated myeloma is unusual, particularly in a young boy. The presence of myelogenous leukemia in a first cousin seems more than coincidental. Both myeloma and myelogenous leukemia are diseases of the bone marrow. In the former, the overgrowth of neoplastic cells seldom overflow into the blood stream. In the latter, they almost invariably enter the general circulation.

Most frequently, myeloma is observed when there are multiple lesions throughout the skeleton. Occasionally, single myelomas are seen and followed to the multiple stage. Cutler, Buscke and Cantrill<sup>6</sup> are of the opinion that myeloma arises as a single focus and metastasizes just as any other malignant tumor. The element of invasiveness characteristic of malignancy is found in the demineralization and destruction of bone. However, the theory of a single focus of myeloma is not held by many investigators.<sup>7</sup> The evidence favors the theory of multiple simultaneous origin of myeloma

usually in association with generalized bone marrow hyperplasia or myelomatosis.

Clinically, there is a predilection of

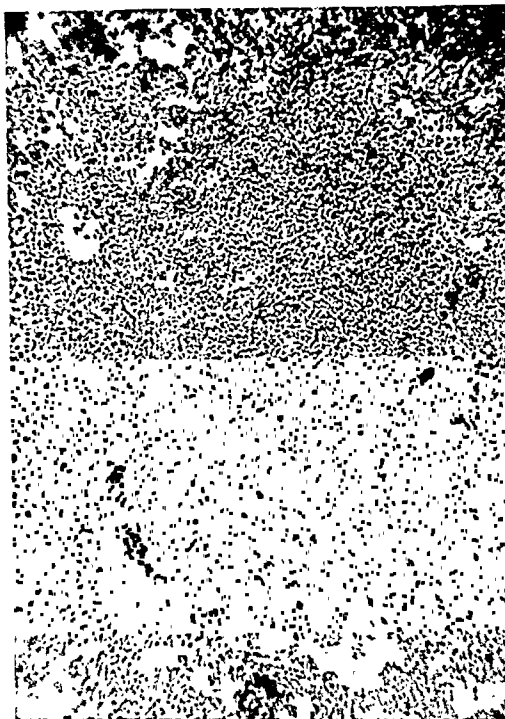


FIG. 4. Histological section of myeloma magnified 75  $\times$  showing cellular tumor with moderate pleomorphism; multinuclear cells and mitotic figures are present.

myeloma for the ribs, sternum, clavicle, vertebra and skull. Roentgenograms usually show the characteristic punched out areas. However, in a diffuse myelomatosis there may be only generalized demineralization with its consequent marked anemia and spontaneous fractures. In this case, diagnosis may be ascertained by sternal puncture. When there is erosion of the bone, there is considerable pain. In the late stages of the disease, there is renal damage with the characteristic Bence-Jones bodies in the urine in 65 per cent of the cases. However, Bence-Jones albumen may also appear in myelogenous leukemia and in metastatic carcinoma when bone marrow is involved.

The natural course of myeloma is about three years, terminating fatally. However, Cutler and Buscke report three cases of



treated isolated myeloma free from disease for periods ranging up to ten years. They claim that isolated myeloma other than the plasma cell type respond to irradiation.

#### SUMMARY

A case of an isolated myeloma of the skull in a fourteen year old boy is recorded. The coincidence of myelogenous leukemia in the family was noted. This case was treated by a combination of surgery and x-ray and followed for a four-year period with an apparent recovery.

#### REFERENCES

1. SYMMERS. *Ann. Surg.*, 67: 687, 1918.
2. GESCHICKTER and COPELAND. Tumors of bone. *Am. J. Cancer*, 1936.
3. PAUL and POHLE. *Radiology*, 35: 651-782, 1940.
4. HABERFELD and LORDY. *Arch. brasil de med.*, 7: 421, 1917.
5. BERTRAND, J. C. et al. *Arch. de pediat. d. Argent.*, 16: 147-159, 1942.
6. CULTER, BUSCKE and CANTRILL. Course of single myeloma of bone. *Surg., Gynec. & Obst.*, pp. 918-932, 1936.
7. SLAUGHTER, DANELY, P. Multiplicity of origin of malignant tumors. *Internat. Abstr. Surg.*, August, 1944.
8. CUTLER and BUSCKE. *Cancer, Its Diagnosis and Treatment*. Philadelphia, 1939. W. B. Saunders Co.



Many malignant tumors fail to metastasize. For example, two types of tumors both of which have the same microscopic pattern and react in a similar manner to the tissues in which they originate, may act in manners far different; one may metastasize and the other remain localized. No doubt metastasis is influenced by resistance.

From "Metastases Medical and Surgical" by Malford W. Thewlis (Charlotte Medical Press).

# HEMANGIOMA OF TENDON

A. M. ARKIN, M.D.

Adjunct Orthopedist, Mt. Sinai Hospital

NEW YORK, NEW YORK

**H**EMANGIOMA of tendon is one of the rarer soft tissue growths. Up until 1937 some twenty-four cases the left ankle, which had been present for twenty years. The tumor was pea-sized when first noted, and had been growing slowly. He



FIG. 1. Microphotograph of section of tumor. The section reveals normal tendon tissue (A) the light staining bundles and whorls in the upper part of the figure. Interspersed among these tendon bundles are numerous dilated tumor blood vessels (B).

(including some of hemangioma of the tendon sheath) had been reported. In that year, Harkins<sup>1</sup> reported the literature to date and added one additional case. There have been no further case reports of this tumor in the literature up to the present.

Because of the relative rarity of this condition, the following case is reported:

M. B., a male hairdresser, aged forty, was first seen on August 17, 1943, with a history of having had a "lump" on the anterior aspect of

had never had any pain until several months before his first visit when he noted pain after being on his feet a good deal. Occasionally swelling was noticed at the same time. He was told by another doctor that this was a fatty tumor.

Physical examination revealed a mass about 10 by 5 cm., with the long axis vertically over the anterior aspect of the left ankle. The mass was soft, elastic, did not pulsate and was not hot or tender. There was no bruit. The mass appeared superficial to the tendons, and the

skin was freely movable over it. There was a full range of motion at both ankle joints. The dorsalis pedis artery was well felt and was equal on both sides. X-ray examination revealed a very small calcific deposit within the tumor mass. The bone structure of the ankle was intact. The preoperative diagnosis was lipoma or xanthoma.

The patient was admitted to Mount Sinai Hospital on August 21, 1943. On the same day, the tumor was removed under cyclopropane anesthesia. A vertical incision five inches in length was made along the course of the tibialis anticus tendon. The transverse ligament of the ankle joint was incised. The tumor was seen as a bluish, fluctuant mass surrounding the tendon and enclosed in its sheath. The sheath was incised and several cc. of serous fluid escaped. The interior of the sheath, which was thickened, was covered with small lobulated and pedunculated "dog-ears" about 1 to 3 mm. in diameter. Along the lateral aspect of the tendon was an adherent, bean-sized tumor mass, soft and well encapsulated, and covered with a smooth synovial membrane, which contained a small area of old hemorrhage and necrosis.

The mass was dissected free from the tendon and excised. The sheath was also excised upward and downward until normal sheath was reached. There was much bleeding. Sulfathiazole powder was instilled and a small rubber dam drain left in the lower end of the wound. A pressure dressing was applied.

The postoperative course was uneventful.

The drain was removed on August 23, 1943. The wound healed rapidly and the patient was discharged on August 29, 1943, walking with crutches.

Microscopic examination by Dr. S. Otani, revealed the following:

"Specimen consists largely of numerous dilated blood vessels, varying in size and shape. These blood vessels in most part intercommunicate with each other, forming cavernous appearances. Some of these dilated vessel spaces contain organizing thrombi and some are completely fibrosed.

"Stroma of the angiomatous structures consist mostly of dense connective tissue, actually tendon structure. However, the tumor structure is found in the adjacent fat tissue and muscle tissue.

"Diagnosis: Hemangioma of tendon."

The patient returned for a check-up examination on February 26, 1944. He reported that he had no symptoms referable to his leg or ankle. There was no numbness, no pain, no limp, no recurrence of swelling, and he could walk any distance at will. Examination revealed that the wound was well healed. There was no evidence of recurrence of the tumor. The tendon of the tibialis anticus moved freely in its sheath and the transverse tarsal ligament had united perfectly so that there was no undue prominence of the tendon on voluntary dorsiflexion.

#### REFERENCE

HARKINS, HENRY N. *Arch. Surg.*, 34; 12-22, 1937.



# PRIMARY FIBROSARCOMA OF THE GREAT OMENTUM

RICHARD H. LAWLER, M.D.,  
Attending Surgeon, Cook County Hospital

PAUL F. FOX, M.D.  
Associate Attending Surgeon, Cook County Hospital

AND

HAROLD COHEN, M.D.  
Surgical Resident, Cook County Hospital  
CHICAGO, ILLINOIS

**P**RI-MARY sarcoma of the great omentum is a rare disease. Grossly two groups of primary sarcoma of the great omentum have been recognized. The solitary or circumscribed tumor in which the surface is generally irregular. The color is some times pale, more often rich vascularization causes a bluish red appearance. Pseudocysts filled with brownish fluid, result from hemorrhage and necrosis. Hemorrhagic ascites is common. The second group includes rather diffuse omental growths. The majority of these are composed of numerous small and large nodules. Though usually solid, they are friable. Metastatic dissemination and non-hemorrhagic ascites occur frequently. The size of the growth may range from that of a grapefruit to a mass weighing many kilograms.

The clinical picture of primary sarcoma of the great omentum is varied. The outstanding initial complaints are pain, mass, and gradual enlargement of the abdomen. The pain may be a constant dull ache localized to the site of the tumor. It sometimes tends to be severe and recurrent. Palpation reveals a fixed mass in the epigastrium, mesogastrium, or the left hypochondrium. The mass will feel solid or cystic, soft or firm, smooth or irregular. The peritoneum and liver are the most frequent sites of secondary sarcomatous invasion. Metastases to the mediastinum, intestines, pancreas and bladder have also been found.

## CASE REPORT

H. H., age eighty years, was admitted to Cook County Hospital, April 18, 1944, com-

plaining of a mass in the abdomen which had been present for one year and seemed to increase in size rapidly during the past four



FIG. 1. Photograph of gross specimen of fibrosarcoma of omentum.

months and was associated with abdominal pain which radiated from the costal margin to the iliac crest and radiated to the mid-line of the abdomen. He also complained of epigastric distress and heart burn after eating and some difficulty in urinating and stated that he had lost no weight.

Physical examination of the patient revealed a well developed and well nourished white male eighty years of age. The temperature was 98.4°F.; the pulse rate 64; the respiratory rate 16. The blood pressure was 130 systolic and 60 diastolic.

Laboratory findings included hemoglobin 70 per cent, white cell count 7,950 with 77 per cent polymorphonuclear leukocytes. The Wassermann reaction was negative. The stools were negative for blood. Palpation of the abdomen revealed a large mass which filled the entire right upper and lower quadrants. The mass did not feel movable with respirations and the edges were hard, and an irregularly circumscribed mass extended to the left lower quadrant just below the umbilicus.

Fluoroscopic examination of the colon revealed some extrinsic pressure on the trans-

verse colon upward and to the left pushing the descending colon laterally toward the distal portion of the transverse colon. The cecum

which before opening was filled with a sero-sanguineous fluid. The lining of the cyst was covered with a thick layer of fibrin. On section

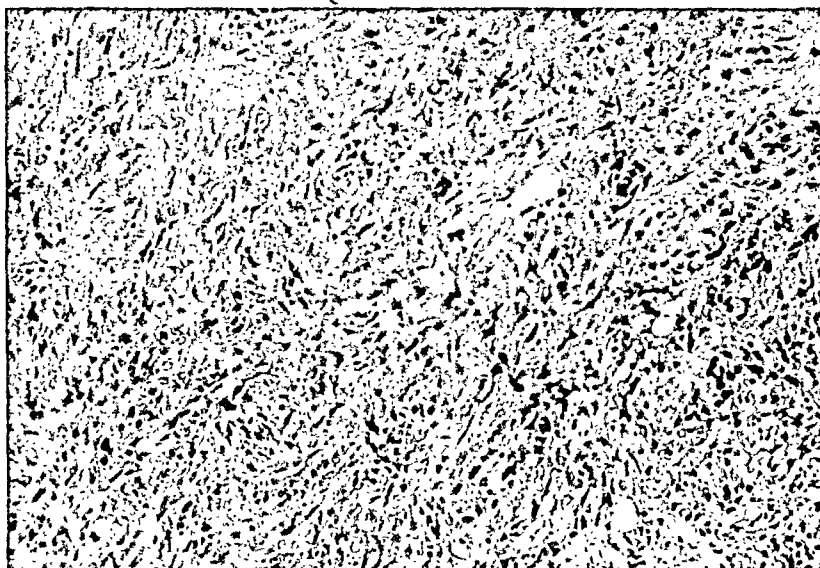


FIG. 2. Microphotograph (X 290) of fibrosarcoma of omentum.

filled well. The findings favored an extracolonic tumor rather than intrinsic pathology of the bowel.

Laparotomy on June 12, 1944, disclosed a moderate amount of fluid in the peritoneal cavity. A large circumscribed tumor of the great omentum firmly attached to the posterior parietal peritoneum to one-half proximal transverse mesacolon, but not involving the blood supply. The mass extended laterally to the ascending colon and extended from the costal margin down into the pelvis. The mass contained about 1,500 cc. of bloody serous exudate and was removed with considerable difficulty.

Postoperatively there was a slight elevation of temperature, otherwise the postoperative course was uneventful. The patient was discharged on the twelfth day, and four months postoperatively he was still in a fairly comfortable condition.

Pathologic examination revealed that the specimen was a large tumor from the omentum that measured approximately 30 by 28 by 8 cm. It was firm, lobulated and formed a large cyst

the tumor was yellowish white and of fleshy consistency.

Microscopically, the section of omental tumor revealed a primary fibrosarcoma.

The above case is reported because of the rarity of the condition and the illustrative clinical and pathological features which it presents.

#### REFERENCES

- RODMAN, J. S. *Ann. Surg.*, 49: 427, 1909.
- EWING, J. *Neoplastic Diseases*. 3rd ed. Philadelphia, 1928. W. B. Saunders.
- MCDONALD, A. L. *Arch. Surg.*, 14: 1245, 1927.
- MANDELSTAMM, A. *Ginek.*, 3: 274, 1929.
- RANSON, H. K. and SAMSON, P. C. *Ann. Surg.*, 100: 523-534, 1934.
- GREIG, D. M. *Edinburgh M. J.*, 37: 237, 1930.
- ROUSSY. *Semaine med.*, Paris, 31: 385, 1911.
- MENNE, F. R. and BERGE, R. F. *Arch. Path.*, 22: 823-828, 1936.
- SANES, S. and KENNY, F. E. *Am. J. Cancer*, 21: 795-804, 1934.
- LEVY, J. H. and PUND, E. R. *Am. J. Cancer*, 40: 219-226, 1940.
- MONTGOMERY, A. H. and WOLMAN, I. J. *Surg., Gynec. & Obst.*, 60: 695-702, 1935.



# WOUND DISRUPTION FOLLOWING COTTON SUTURES

VINCENTE D'INGIANNI, M.D.

On Staff of Charity, Mercy and French Hospitals

NEW ORLEANS, LOUISIANA

WHEN we say that cotton has proved to be one of the best suture materials, we by no means infer that it is infallible. We can still expect an occasional wound disruption. Although cotton is claimed to be one of the least irritating substances to the host, and promotes the laying down of collagen fibrils and later connective tissue proliferation, nevertheless there are cases in which the host fails to respond by producing fibroblasts.

The cause of this failure of response is not completely known. Avitaminosis, generalized debilitation, the incorporating of the omental tag in the wound, and contamination of the wound edges have been suggested as possibilities. However, there are patients who have been resutured with the same material after wound disruption and their wounds have healed without the administration of vitamins. There have been innumerable emaciated individuals who have recovered with primary intention. The fact that the omentum succeeds in passing through a portion of the incision should not cause the entire wound to disrupt upon the removal of sutures, yet this has happened repeatedly. In many cases in which there has been gross contamination of wound edges and the surgeon expects disruption, the patient recovers uneventfully. Therefore, there must be some other factor, probably a hormonal substance which stimulates the production of fibroblasts by the incised tissue. This being so, lack of the hormone would cause wound disruption; or the implanted substance might cause a neutralization of the hormone, or produce a digestive reaction which would free the host of the suture material.

The hormone theory is of course only a conjecture. But it is quite evident that wound disruption cannot be wholly blamed on the kind of suture material, nor solely

on the lack of vitamins or proteins, nor on contamination alone. With these ideas in mind, the following report is given of a patient in whom complete disruption took place when cotton was used.

## CASE REPORT

On December 7, 1943, a white male, aged fifty-five, had a cholecystectomy and appendectomy under general anesthesia through a right upper rectus incision. Each tissue layer was closed with interrupted cotton sutures: No. 40 being used for the peritoneum and fascia; the angle of the fascia was closed with No. 8 suture figure-of-eight type; the skin was closed with No. 8 cotton, used interruptedly.

On the first day the patient was permitted to sit up in bed and made to cough. On the third day his temperature was 103°F. with râles over the left lung. X-ray revealed left lower lobe pneumonia. He was given sulfathiazole intravenously because he began vomiting. By the seventh day he had become afebrile for twenty-four hours and was eating well. The skin sutures were removed on the eighth day, and there was no apparent infection or disruption of the skin. On the ninth day the patient began feeling badly, and inspection of the wound revealed loops of bowel herniating through the incision. Spinal anesthesia was immediately given and the wound was inspected after replacing the bowel. There was a disruption of the lower angle and of the lower half of the wound. With slight pressure the upper portion of the wound fell apart. None of the cotton sutures could be recovered, not even those in the angle which were of heavier material.

This patient was a well nourished individual who had been given ten days of high caloric diet and intramuscular injections of vitamins as preventive measures. No contamination of the wound edges was found, and the abdominal layers were closed carefully with interrupted sutures. The skin edges upon inspection showed healing by first intention. Thus, in this case, wound disruption occurred although the popularly accepted causes were ruled out in advance.

---

---

# New Instruments

---

## A PERITONEAL CLAMP\*

### ITS USE IN FIFTY CASES

ROBERT F. BARBER, M.D.

Director of Surgery, College Surgical Service,  
Kings County Hospital

AND

R. ROBERT DE NICOLA, M.D.

Assistant Resident in Surgery, College Surgical Service,  
Kings County Hospital

BROOKLYN, NEW YORK

THE routine method of opening into the peritoneal cavity, if followed carefully, is safe. This method includes

fall away from the peritoneal surface; (2) to grasp a tuck of peritoneum between two forceps and to compress this portion of

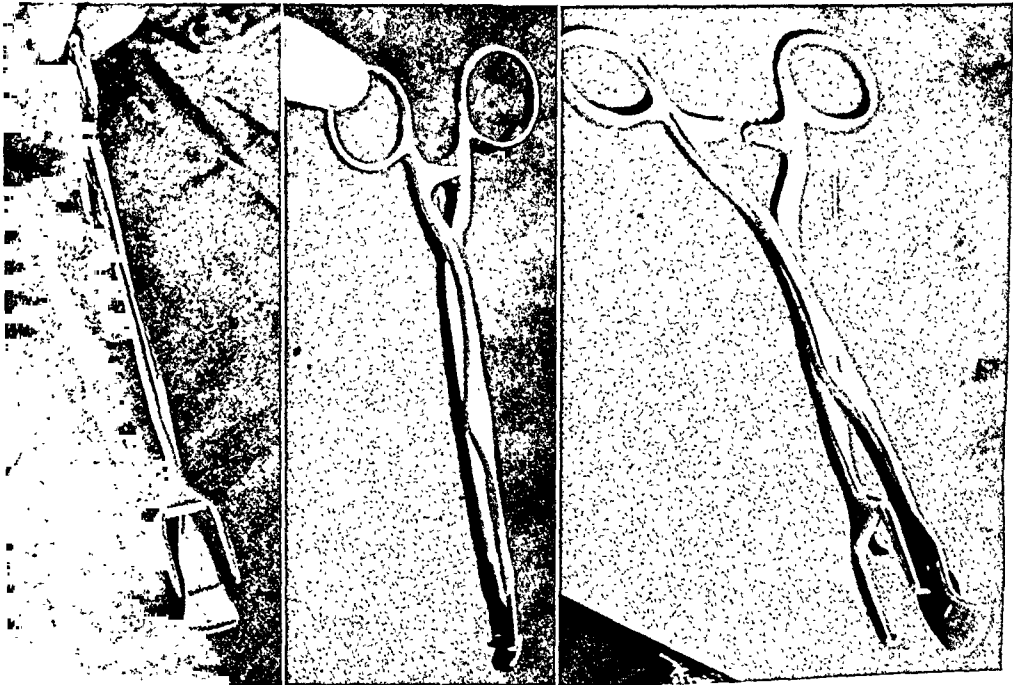


FIG. 1. The clamp: A, as seen from front; B, side view; C, clamp opened.

definite measures taken to avoid opening into the intestines. The steps necessary for the safe opening through the peritoneum are as follows: (1) To retract the musculo-aponeurotic structures upward, thereby increasing the normal negative intra-abdominal pressure so that the intestines

tissue with a blunt instrument to make certain that the intestine is not included in the grasp of the forceps, and (3) to incise this tuck of peritoneum over a blunt instrument.

The directions for the safe opening of the peritoneum are not always followed.

\* From the Department of Surgery, Long Island College of Medicine, and the College Surgical Service, Kings County Hospital, Brooklyn, N. Y.

Either carelessness or unwarranted speed lead to omission of steps 2 and 3, thereby leaving underlying viscera unprotected.

with the use of one hand, to pick up peritoneum and clear its undersurface, while the other hand is left free to incise

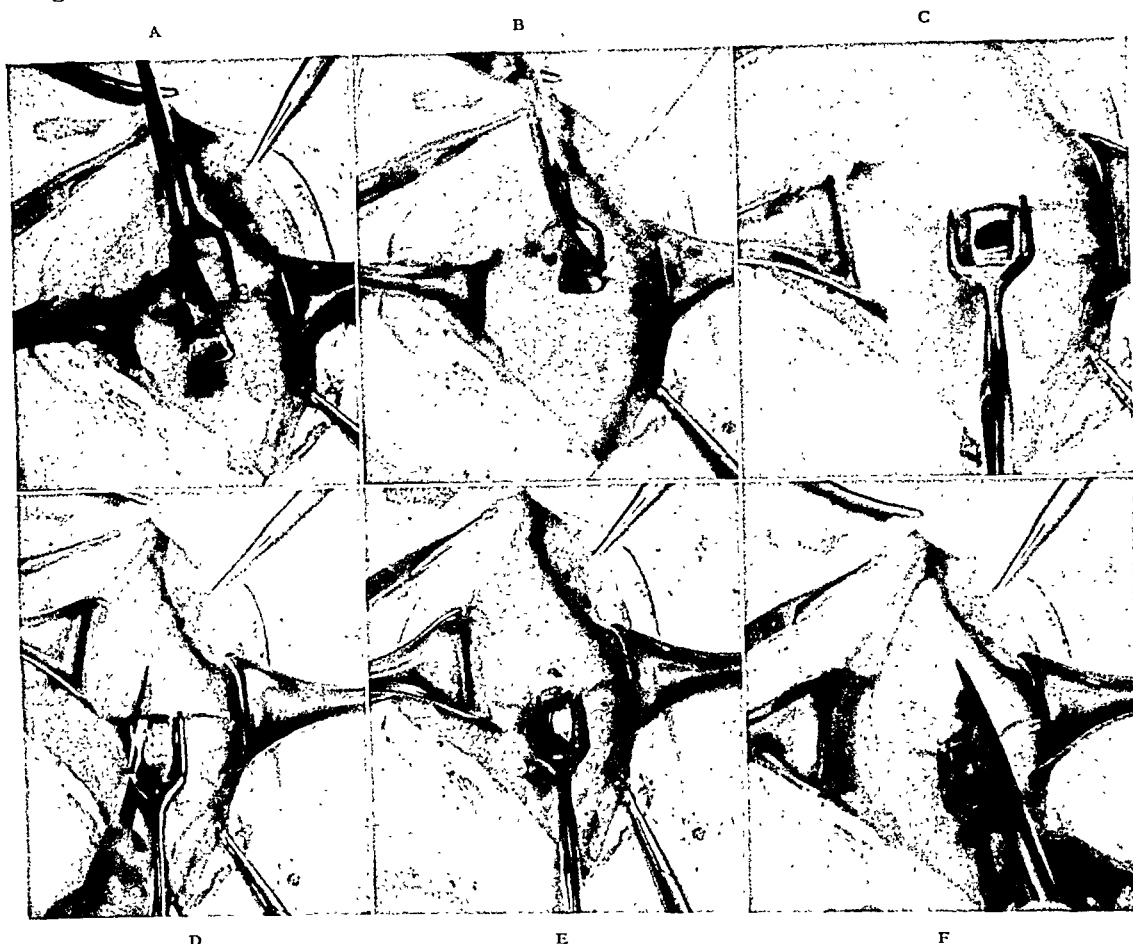


FIG. 2. A, the tenaculæ of the forceps-blade engaging the peritoneum; B, the clamp is closed to its third ratchet; C, the clamp is drawn downward and backward; a tuck of peritoneum is now tented over the blunt curved protector; D, peritoneum incised over the blunt blade; E, opening is made through the peritoneum; opening is seen showing the transversalis fascia, properitoneal fat and peritoneum; F, opening enlarged in the usual manner.

Following the principles of the standard method of opening the parietal peritoneum, we have devised a clamp which automatically protects the intestine when the peritoneum is incised.

The peritoneal clamp\* consists of two blades, one representing two forceps and the other a compressing, blunt instrument. The blunt blade sweeps away the underlying intestine and locks a portion of peritoneum between the forceps of the first blade. The instrument allows the surgeon

with scalpel. The structure of the clamp is shown in Figure 1.

As seen in Figures 2 and 3, the forceps blade of the clamp is inclined forward and inserted into the peritoneum. The peritoneum is then lifted and the clamp closed while it is carried downward and backward so that in its final position it is nearly horizontal with the abdominal wall. A portion of peritoneum 1.5 by 1.5 cm. will be "tented" over the blunt curved blade and this tuck of peritoneum is incised. The tenaculæ of the forceps blade will hold the peritoneum opened as the

\* The clamp was made by J. Sklar Co., through the courtesy of E. J. Sovatkin.



opening is enlarged in the usual manner. The entire procedure is done in a matter of seconds, adding the factors of simplicity, above and below the semilunar fold, lateral to the sheath of the rectus and also in the midline. In numerous instances a trans-

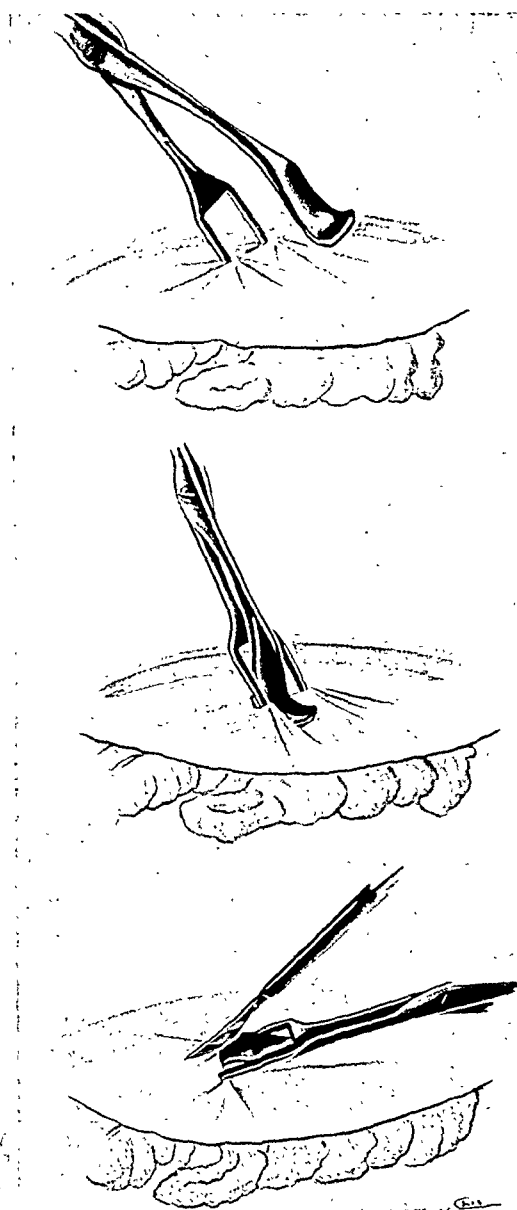


FIG. 3. The forceps blade of the clamp is inclined forward and inserted into the peritoneum. The peritoneum is then lifted and the clamp closed while it is carried downward and backward. A portion of peritoneum will be tented over the blunt curved blade and this tuck of peritoneum is incised.

one man control and greater safety to the act of entering the peritoneal cavity.

The peritoneum has been opened in this manner in fifty cases. The clamp was used

verse incision was made. The peritoneal clamp was used successfully in opening the peritoneum under all types of anesthesia.

---

---

# The American Journal of Surgery

Copyright, 1945 by The American Journal of Surgery, Inc.

A PRACTICAL JOURNAL BUILT ON MERIT

*Fifty-fourth Year of Continuous Publication*

NEW SERIES VOL. LXIX

AUGUST, 1945

NUMBER TWO

---

## Editorial

### THE MANAGEMENT OF CARCINOMA OF THE UTERINE CERVIX

IT has been stated that approximately one-third of all carcinomas in women occur in the uterus and that 90 per cent of them are found in the uterine cervix. Thus, this lesion assumes important proportions. According to the Cancer Committee of the League of Nations, carcinomas of the cervix are divided clinically into four distinct groups. In group I, the growth is limited entirely to the cervix, the uterus is freely movable, and no paracervical infiltration can be detected. In group II the parametrium is involved; the infiltration can be palpated under the vaginal wall or beside the cervix; the palpable infiltration may extend outward nearly to the pelvic wall, but the uterus still retains mobility. In group III the parametrium is involved to the pelvic wall on one or both sides, with partial or complete fixation of the uterus. In group IV the carcinoma has invaded adjacent viscera or extensively involved the vagina, or has produced distant metastases.

The history of operative gynecology may be said to have been written around the treatment of carcinoma of the cervix. Originally cauterization of the neoplastic cervix by means of the soldering iron or by chemicals was employed; this method was improved by the development of the electric cautery. About all that this could

accomplish was the conversion of a foul sloughing ulcer into a clean one; rarely was a cure observed; and this only in the earliest or smallest lesions. Percy and a few followers advised the use of the Percy cautery. This method, which was short-lived, was at its height during the second decade of this century. Certain cures have been observed with high amputation of the cervix at the level of the isthmus, when the lesion was at its earliest stages and when the incision had been made in sound tissue some distance above the involved area; but the advocacy of a restricted operation when a more extensive one might be performed in the fight against cancer proved to be a false therapeutic conception. Next came vaginal hysterectomy, first with clamps and then with sutures, both methods showing disappointing results.

With the advent of abdominal surgery, simple abdominal panhysterectomy with the ablation of the adnexa came into vogue. First performed by W. A. Freund, in 1878, it was commonly practiced at the end of the nineteenth and at the beginning of the present century. Recurrence was the rule following simple vaginal and abdominal panhysterectomy with the removal of the adnexa, since these operations were not extensive enough to remove all

the involved tissue, and five and ten-year arrests of the disease were exceptional.

In 1895, at the Congress of Frankfurt, Emil Reis, of Chicago, gave the first systematic description of enlarged or radical hysterectomy as practiced today, although at that time he had not performed the operation. This procedure consisted of removal of the uterus with its adnexa, the parametria, a vaginal cuff of sufficient length, and the involved regional nodes. The first operation following these principles is said to have been performed by John J. Clark of the University of Pennsylvania. The name of Wertheim has become attached to the radical abdominal operation because of his painstaking records, his careful follow-up of patients, his searching histological studies, and his extensive publications. The Wertheim operation consists of the ablation of the uterus, the tubes and ovaries, the parametria, the iliac and obturator glands when removable, and almost all of the vagina. Wertheim advised the use of right-angle clamps on the vagina in order to shut off the cervical neoplasm from the surrounding structures while removing the pelvic organs. The Latzko operation is somewhat more extensive than the Wertheim, since there is greater separation of the connective tissue under the uterine artery and lateral to the ureter. There is also a wider removal of the parametrium, the paravaginal tissue, and the tissues below the bladder floor.

A number of pelvic surgeons, led by Jonnesco, extended the dissection to the search and removal of the sacral and lumbar glands. This was soon abandoned by most operators, however, as it was believed that when these glands were involved the carcinoma was beyond surgical control.

The Wertheim operation was popular in the second decade of this century. This operation, radical and formidable though it was, greatly improved the results, and was responsible for a constantly increasing number of five and then ten-year arrests of the disease. While Wertheim and others were developing the abdominal operation,

Schauta was elaborating radical vaginal hysterectomy, a method that also gave durable results but that could not enter into real competition with the abdominal procedure; because when operation was done vaginally, the pelvic lymph nodes could not be dissected and removed. Subsequently, Adler added radium capsules to the sides of the pelvis after performing an extended vaginal hysterectomy.

During the time the Wertheim operation was extensively practiced the mortality was high, since in those days preoperative and postoperative treatment were not so well developed as they are today, since blood transfusion had not been well elaborated, and since the sulfa drugs and penicillin were unknown. Nevertheless, it was the only means of combatting a disease that was universally fatal if allowed to run its course unchecked.

Radium was discovered by the Curies and G. Bémont, of Paris, in 1898, but did not receive serious consideration in the management of carcinoma of the cervix until the end of the second decade of this century. It was originally employed only when the operation could not be performed—in the so-called inoperable cases. Group I and a number of group II cases were selected for surgery, while some group II cases, all group III cases and some group IV cases were selected for radium therapy. The striking results obtained by radium in the healing of the primary lesion in a large number of unfavorable cases were responsible for the extension of its use to group II and group I cases, until eventually, in America at least, the radical operation was almost totally abandoned. Simultaneously, with the use of radium, high-voltage x-ray was developed, perfected and used in conjunction with radium therapy. As time went on it was discovered that women who had been cured of carcinoma of the cervix by means of irradiation with radium and x-ray died of metastases. This led to the belief that neither radium nor x-ray cured patients when the regional glands were already involved in carcinoma.

Victor Bonney wrote: "I have on many occasions, at the close of the operation, discovered an infiltrated gland or mass of infiltrated cellular tissue so adherent to the great vessels as to be irremovable. All these patients were treated by x-ray, but in spite of a definite target to aim at, not one was saved."<sup>1</sup>

The inability of irradiation by means of radium and high voltage x-ray to destroy regional carcinomatous glands led Taussig, in the decade 1930 to 1940, to develop and recommend his method of pelvic lymphadenectomy combined with radiation therapy. In 1943, he reported 175 such operations performed by him and his associates, with a primary mortality of 1.5 per cent and a relatively high survival rate in group II cases of carcinoma of the cervix. A number of gynecologists may have recognized the value of Taussig's contribution, but few followed in his footsteps. Practically all those who had been trained in the technic of the radical abdominal operation believed that pelvic lymphadenectomy did not solve the problem, but that if surgery were attempted, the uterus and adnexa, the parametria, and most of the vagina should be removed in addition to the regional lymph glands. Some operators have continued to use the radical abdominal operation in selected cases, and a few others have taken it up more recently. As it is practiced today in this country it is limited largely to group I cases—those that are considered good surgical risks. Under this régime the primary mortality has been reduced nearly to that of simple abdominal panhysterectomy. Credit for these results should be given to better preoperative and post-operative care, to the transfusion of blood plasma and whole blood, to the sulfa drugs and penicillin, and to the judicious use of

radium to heal a sloughing cervix previous to operation, thus minimizing the danger of severe infection in the form of peritonitis or septicemia. Group I cases considered poor surgical risks, group II and group III cases, and some group IV cases are treated by irradiation with radium and x-ray. The histologic classification of Broders and Martzloff have been valuable in grading squamous cell carcinoma of the cervix and have been helpful in determining the prognosis of those treated by irradiation. They point out those cancers made up of cells that are sensitive or non-sensitive to the radiating elements.

On the whole, it has been recognized that adenocarcinomas and adenoacanthomas of the cervix respond better to surgery, when it can be applied, than they do to radium and x-ray. The main contraindications to radical abdominal hysterectomy, no matter at what stage of the disease, are gross obesity and severe co-existent disease.

In the light of our present knowledge, the best results in the treatment of carcinoma of the cervix will be attained by an intelligent combination of surgery and irradiation. Furthermore, experience has taught the most successful results are obtained when the original treatment, be it surgery or irradiation, is adequately applied, since incomplete surgery or insufficient irradiation inevitably leads to recurrences, treatment for which is almost always unsatisfactory.

The pelvic surgeon who has had the opportunity of perfecting himself in the technic of the radical abdominal operation has also benefited by having acquired a better knowledge of the anatomy of the pelvis. Thus, he has obtained confidence, and the ability to perform other types of pelvic operations which he could not have obtained by other means.

LOUIS E. PHANEUF, M.D.

<sup>1</sup> *J. Obst. & Gynaec.*, 48:421, #4.



---

# Original Articles

---

## PLASTIC SURGERY OF NASAL FRACTURES\*

EDWARD S. LAMONT, M.D.

HOLLYWOOD, CALIFORNIA

**F**RACTURES of the nose are frequently overlooked. The initial swelling, coupled with frequent epistaxis and ecchymosis mask the normal nasal contour, so that gross deformity may not be apparent. Lateral x-rays are often helpful but these too may be misleading. Thorough examination may be painful and the patient is all too ready to persuade the surgeon that there is no fracture.

Many papers have been written on the signs, symptoms and treatment of early fractures.<sup>2,5,12,15,16</sup> Stress has been laid, not only on restoration of the bony vault, but also the cartilaginous structure and the septum. Few rhinologists have ever seen a thoroughly straight septum in the adult which would lead one to believe that incidental nasal trauma suffered in childhood results in malformation of growth. Too often a patient with a perceptibly crooked septum can recall no history of fracture.

Unreduced nasal fractures are not only cosmetically unattractive but interfere with the physiology. Should the fracture occur early in life, growth of the structures may be impaired, and this must be kept in mind when reconstructive procedures are contemplated. (Fig. 7.) A severely traumatized nose should be considered fractured until proved otherwise. When reducing an early fracture, the surgeon should attempt only to return the structures to their previous position.

In this paper we shall deal primarily with the deformities resulting from un-

reduced nasal fractures, and report further on the experimental and clinical course of necrocartilage.

### EVALUATION OF THE DEFORMITY

*Pre-surgical Study.* The surgical technic is elastic and will depend on the type of deformity presented. In each case a plaster cast is taken of the face. One side of the nose is measured and marked to indicate the desired size, shape and contour of the nose that will both correct the deformity and fit the patient's face. If there is a depressed fracture or marked saddle, modelling clay is used to build up the deformity. Photographs are taken: profiles, profiles smiling, front view, the triangle of the nose with the head tilted backward.

*Nasal Septum.* The presence of a deviated septum is not always an indication for a submucous resection. The latter should be performed only when it is causing a mechanical obstruction, or interfering with the normal physiology of the nose and accessory sinuses. Often a slight deviation in the presence of a vasomotor rhinitis or allergic condition will appear to be causing mechanical blockage. Surgery on the septum will not alleviate this condition; the turbinates will merely bulge further to meet the wall. The surgeon, therefore, should judge each case carefully before performing a submucous resection.

When this operation is indicated in cases of old nasal fracture, it should be done thoroughly. Merely removing a section of

\* Presented in conjunction with colored surgical motion pictures as part of a series of Faculty Lectures to the War-Time Graduate Medical Meetings (Army and Navy General Hospitals) Zone 24, under the auspices of the American Medical Association, the American College of Physicians and the American College of Surgeons.

the cartilaginous septum, a guilty spur or a small portion of the supposedly obstructing septum, will usually prove

partner in causing the nose to be crooked. (Figs. 3, 4 and 6.)

We have attempted many methods in



FIG. 1. Fracture of the nose with a depressed bridge, dropped tip, flattened nostrils and disappearing columella. Complete reconstruction was required with insertion of a cartilage graft over the dorsum and within the columella.

quite disappointing both to the patient and the surgeon. Unless sufficient ethmoid plate, vomer, bony maxillary ridge and cartilage are taken, the mucous membrane which becomes thickened after surgery merely bows over to its old position. The surgeon should consider that once a sub-mucous resection is done, the septum cannot be reoperated without danger of a perforation. When necessary, it has been found advisable to carry out the sub-mucous resection four to five months following the nasal reconstruction.

Displacement of the septal cartilage in the unreduced fractured nose is almost the rule. The displacement not only interferes with the nasal physiology but is cosmetically unattractive as it protrudes from one nostril in many cases and often is a

relocating the septum and holding it in position.<sup>4,9,13,14</sup> In some cases we have pierced it with a wire and run the latter to an opposite incisor; run a wire protected by a lead plate to the opposite ala; made a circular incision along the septum to allow it to bend. We now use the following method and find it quite satisfactory: Prior to removing the required amount of septum from its inferior and anterior aspects, an Asch forceps is introduced, one blade passing between the septum and disengaged columella, the other parallel along the nasal floor. The cartilaginous septum including the vomer is tightly grasped and forcibly bent in the direction opposite to that of the deformity. After thorough loosening the septum is rocked several times. The blades of the Asch forceps are

then passed upward, now grasping the cartilaginous septum and the ethmoid plate; a similar procedure is repeated as

It is obvious that should a fracture dislocation occur during the growth and developmental period, an interference with



FIG. 2. Old nasal fracture with a twisted dorsum and a markedly deviated septum. A total osteoplastic reconstruction was performed.

below. Meticulous care is taken to sew the columella to the septum with interrupted silk sutures. The results have been quite satisfactory and we have had no untoward reactions.

**Bridge.** The majority of fractures result in injury associated with a dislocation of the nasal bones. Less rarely is the nasal process of the maxillary bone injured. With a shifting of the osseous structures, the upper lateral cartilages often suffer fracture or dislocation. (Figs. 2 and 10.)

The upper lateral cartilages are a direct continuity of the cartilaginous septum. Their posterior superior borders are in fibrous contact with the nasal bones and the ascending frontal process of the maxilla. The inferior border has a fibrous attachment to the lower lateral cartilages.

the bony and cartilaginous bridge will affect the contour of the whole nose.

Correction of the bony deformity is carried out by removing the anterior excess with bayonet bone saws, then performing a lateral osteotomy through the nasal process of the maxillary bones and deflecting the distal fragments medially. (Fig. 5.) A chisel is introduced in the center of the osseous bridge between the nasal bones and the ethmoid plate to gain greater freedom for the immobilized maxillary fragments.

The upper lateral cartilages are severed from the septum in the midline and a hyperbolic wedge is taken on either side, which not only narrows the nose to the required measurements but also allows more breathing space.

*Tip.* The contour and position of the nasal tip is determined by the lower lateral cartilages and the septum. Injury to

lateral cartilages may be buckled and the tissues hypertrophied. (Figs. 1 and 9.)

Often the septum on the very tip may be



FIG. 3. Patient suffered a broken nose ten years ago. The septum was dislocated to the right and the lower lateral cartilage on the same side was more prominent. A and C, depicting the associated congenital deformity with a second degree hump, a dropped tip and relatively long anteroposterior dimensions. B and D, after surgery: relocation of the septum into the vomer groove and complete reconstruction of the nose.

nasal structures may cause the tip to be dropped, flattened, bent or asymmetrical. If the injury is of long standing, the lower

bent causing the whole lower half of the nose to be deviated to the affected side. We have found the following procedure





FIG. 4. A nasal fracture in childhood caused a septal dislocation with deviation of the septum but no marked blockage of breathing. The septum was relocated with an Asch forceps while carrying out the nasal plastic operation.

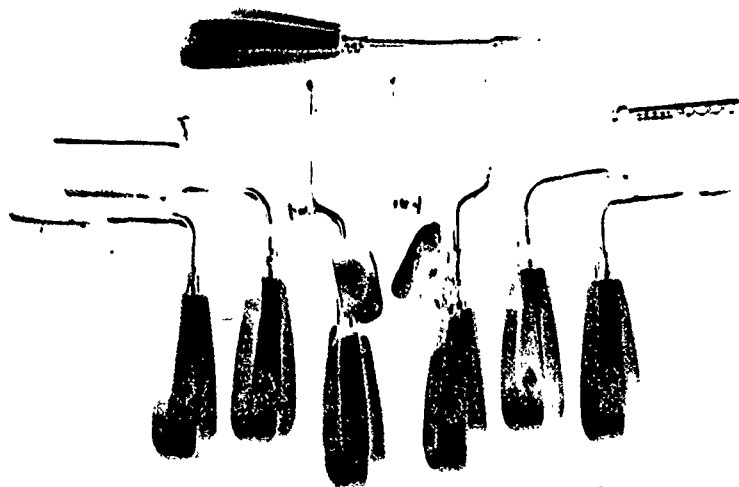


FIG. 5. Author's nasal saws: The handles are rounded and bevelled to fit the operator's palm. Thumb rests on the two dorsal saws assure a firmer grasp. The teeth are in a double row bevelled to a "V." Guards constructed for the cutting edge of the saws prevent injury to the teeth while they are being autoclaved and handled.

to be effective in the correction of such a deformity. The septal mucous membrane on the affected side is undermined and

spine; each succeeding incision more forward. The knife is carried through to the opposite mucous membrane lining and a



FIG. 6. Old nasal fracture with dislocation of the septum. A and C show the twisted bridge, asymmetrical nostrils and relatively long anteroposterior tip dimensions. B and D, after surgery; the bridge and tip have been reconstructed in conjunction with relocation of the septum.

raised. Two or three circular incisions are made on the septum extending from its mid-anterior aspect down to the nasal

sliver of septum removed in each position. The reflected mucous membrane is returned to position and several through-

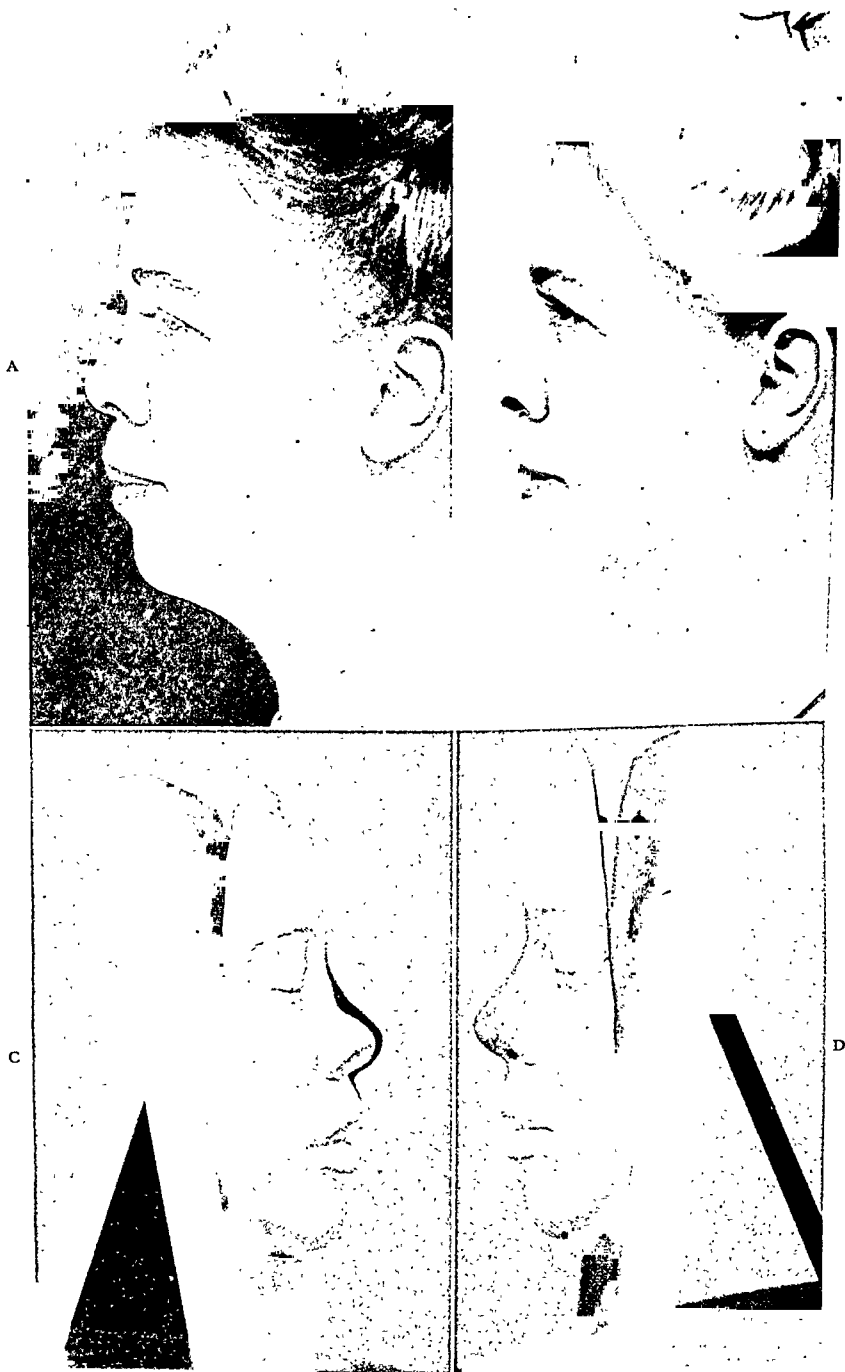


FIG. 7. Fracture of the nose suffered in childhood, resulting in injury to the vomer and causing maldevelopment of the septum. A, B and C demonstrate the saddle bridge with a disappearing columella. The plaster cast modelled with clay depicts the required cartilage graft and plan of reconstruction. D, cartilage was prepared and sculptured to the required measurements. The grafts were then inserted intranasally.

and-through staggered sutures are taken between the separated sections of septal cartilage.

and human cartilage, metals, paraffin and many others have been included.

Several years ago we began to follow



FIG. 8. Old fractured nose in conjunction with a markedly deviated septum. A complete nasal reconstruction was required. Two small rounded plates of cartilage were placed immediately beneath the lower curve of the alae to elevate their position. A thorough submucous resection was performed four months later.

Reconstruction of the lower lateral cartilages should be done meticulously. They are first dissected free without disturbing the nasal lining and thoroughly undermined away from their beds.<sup>8</sup> The requisite amount is then removed allowing the lateral crus to slide medially and form the new tip. We do not hesitate to go below the arch medially when attempting to decrease the antero posterior dimensions of the nasal tip. When necessary a suture is placed between the septum and the columella-philtrum angle.<sup>1</sup> The intranasal incisions are carefully sutured with silk.

#### DEFORMITIES REQUIRING THE ADDITION OF CARTILAGE

Various materials have been used to reconstruct absent skeletal and cartilaginous tissue of the nose.<sup>3,10,11</sup> Human and animal bone, ivory, celluloid, animal

the course of necrocartilage both experimentally and clinically in the human.<sup>6,7</sup>

*Experimental Method.* Rib cartilage is taken from patients in exitus and the perichondrium removed. It is fixed in formaldehyde solution (4 per cent formalin) four days, washed, then refrigerated in colorless merthiolate solution 1:1,000. When cartilage was required to repair a defect, a section was taken from the same piece and placed beneath the skin of the anterior abdominal wall. In chronological periods of time, i.e., a week, a month, six months, a year, two years and three years, the cartilage was removed from the anterior abdominal wall and examined microscopically.

Pieces of the same cartilage were retained in the merthiolate solution, refrigerated and examined at the identical times for comparison. Sections of autogenous rib cartilage were similarly followed for comparison.



FIG. 9. Injury to the nose resulting in flattened upper lateral cartilages, dropped tip, deformed nostrils and disappearing columella. Total reconstruction with a cartilage graft to the columella.

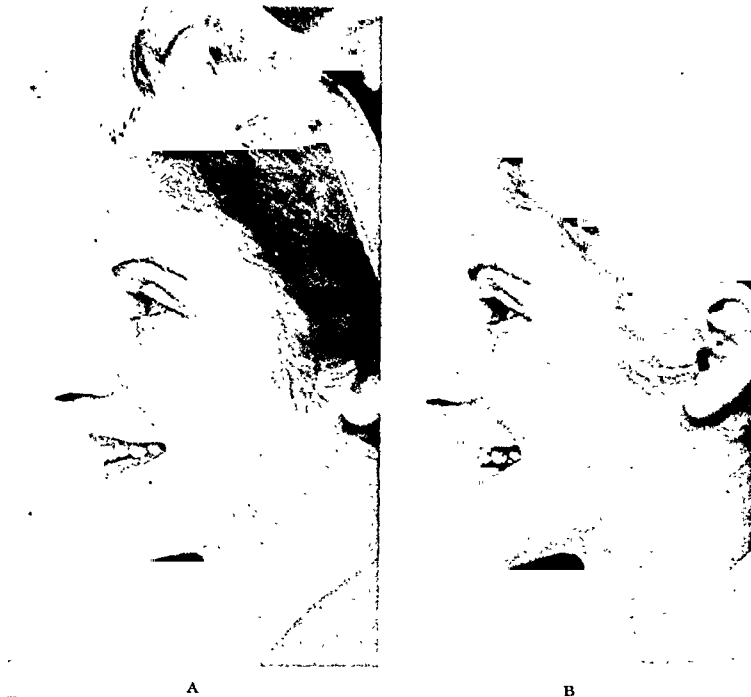


FIG. 10. Old fracture of the nose in conjunction with a congenital deformity. Complete nasal reconstruction required with relocation of the septum into the vomer groove. The bridge was lowered and the tip reconstructed to the required size.

*Evaluation of Results.* Cartilage removed from the pocket in the anterior abdominal wall and examined after one week, demonstrated the central cells to be blue stained, with prominent nuclei. In some places the cells were vacuolated. The periphery stained pink with moderate dissolution of the cartilage cells.

After forty-four days, microscopic examination of a similar piece of cartilage removed from the anterior abdominal wall revealed a somewhat identical picture with little other change in the cartilage. One piece of necrocartilage removed from the anterior abdominal wall after three years presented a solid piece of cartilage that grossly resembled freshly prepared necrocartilage. When cut, its consistency was similar and there were no areas of disintegration. Microscopically, the cartilage showed some fibrotic invasion of the periphery and the cells stained pink. Centrally the cartilage cells accepted a bluish stain and appeared similar to the sections examined after forty-four days.

#### NASAL DEPRESSIONS REPAIRED WITH CARTILAGE

A plaster cast of the patient's face is taken and modelling clay is utilized to reconstruct the nasal defect. Refrigerated necrocartilage is then sculptured to conform to the clay model. Several small holes are bored in the cartilage to allow the entrance of granulation tissue and thus "rivet" the cartilage in place. After the cartilage has been sculptured to the required measurements it is returned to the merthiolate solution and refrigerated until needed for the surgery.

*Surgical Method.* Often a cartilaginous strut when inserted intranasally will improve the defect but will not gain the best cosmetic and functional result. The presence of a depression of the bridge or a disappearing columella is not an indication to forego the reconstruction of the remainder of the nose. If necessary, we may narrow the bridge, remove the required

amount of upper lateral cartilage, reconstruct the tip and carry out such procedures that will effect a more pleasing result.

When cartilage is employed over the bridge, an incision is made between the upper and lower lateral cartilages and a pocket created that will meet the size of the implant. The latter is sprinkled with sulfanilamide crystals, inserted and the incision in the mucous membrane sutured with black silk. The nose is lightly packed with gauze, and careful adhesive tape dressings are applied.

By preparing the cartilage implant several days prior to surgery and allowing it to refrigerate in an antiseptic solution, it is handled a minimum in the surgery and so offsets the threat of infection.

Cartilage thus prepared may be employed as framework for any part of the nose, i.e., a strut in the columella from the tip to the nasal spine, or at the point where the philtrum meets the columella to repair a depression of the latter.

*Clinical Results.* We have used necrocartilage intranasally in seventy-five cases. Some in this series have been followed over a period of three years. Careful examination reveals no marked clinical change of these cartilaginous implants.

We have lost cartilage in only two cases. Both were at the columellar-philtrum juncture for repair of a depression. In the first, the patient suffered a severe blow on the nose one week after surgery. In the second, we believe the pocket was made too small to house the strut of cartilage and as a result it began to extrude the day following surgery.

In comparison, the clinical course of necrocartilage is similar to that of autogenous cartilage. Its advantages are obvious in that no chest operation is necessary, it may be modelled before surgery, the quantity is not limited, and, too, we believe that allowing it to remain for a time in refrigeration gives it an opportunity to curl *in vitro* rather than *in vivo*.

## CONCLUSIONS

1. The unreduced fractured nose must be reconstructed physiologically as well as cosmetically.
2. Necrocartilage has proved a valuable adjunct in repairing nasal depressions.
3. Careful preoperative study is mandatory to gain the required result.

## REFERENCES

1. AUFRICHT, GUSTAVE. A few hints and surgical details in rhinoplasty. *Laryngoscope*, 53: 317, 1943.
2. BROWN, JAMES B. Reconstructive surgery of the nose. *Nelson Loose Leaf Surgery*, 8: 237-266, chap. II, 1940.
3. BROWN, JAMES B. Preserved and fresh hemotransplants of cartilage. *Surg., Gynec. & Obst.*, 7: 599, 1941.
4. COHEN, SAMUEL. Role of the septum in surgery of the nasal contour. *Arch. Otolaryngol.*, 31: 12-20, 1939.
5. FOMON, SAMUEL. The treatment of old unreduced nasal fractures. *Ann. Surg.*, 104: 107-117, 1936.
6. LAMONT, EDWARD S. Plastic surgery in reconstructing the partially absent nose. *Ann. Otol., Rhinol. & Laryngol.*, 53: 561-568, 1944.
7. LAMONT, EDWARD S. Reconstructive plastic surgery of the absent ear with necrocartilage. *Arch. Surg.*, 48: 53-72, 1944.
8. LAMONT, EDWARD S. Reconstructive surgery of the nose in congenital deformity, injury and disease. *Am. J. Surg.*, 65: 17-45, 1944.
9. METZENBAUM, MYRON. Dislocation of the lower end of the nasal septum. *Arch. Surg.*, 24: 78-88, 1936.
10. PEER, LYNDON A. Plastic surgery for 1942. *Arch. Otolaryngol.*, 38: 171-189, 1943.
11. PIERCE, G. W. and O'CONNOR, G. B. Reconstructive surgery of the nose. *Ann. Otol., Rhinol. & Laryngol.*, 47: 437, 1938.
12. SAFIAN, J. and TAMERIN, J. Recent fractures of the nose. *Am. J. Surg.*, 31: 10-23, 1936.
13. SALINGER, SAMUEL. Traumatic deformities of the nasal septum. *Ann. Otol., Rhinol. & Laryngol.*, 53: 274, 1944.
14. SHEEHAN, J. E. *Plastic Surgery of the Nose*. New York, 1936. Paul Hoeber, Inc.
15. SMITH, FERRIS. *Reconstructive surgery of the head and neck*. Nelson Loose Leaf System. New York, 1928. Thomas Nelson and Sons.
16. STRAITH, C. L. and DE KLEINE, E. H. Modern management of the fractured nose. *Collective Review. Internat. Abstr. Surg.*, 66: 9-15, 1938.



# BILATERAL NUMMIFORM FIBROMYOMAS OF THE NIPPLES WITH UNILATERAL FIBROMYOMA AND PAPILLOMA MAMILLAE\*

JOHN J. CUNNINGHAM, M.D.,

Chairman of Surgical Department, Binghamton City Hospital

SAMUEL E. COHEN, M.D.

Assistant Pathologist, Binghamton City Hospital

AND

JOHN R. CUNNINGHAM, M.D.

Resident in Surgery, Binghamton City Hospital

BINGHAMTON, NEW YORK

TUMORS of the nipples, exclusive of Paget's disease, find infrequent and discontinuous mention in gynecological-surgical discussions. In 1900, Lindfors<sup>15</sup> wrote, "It is peculiar that the knowledge of this form of mammary gland tumor which previous authors like Cooper and Chelious encouraged, suddenly disappeared from treatises on the diseases of the breast in succeeding decades. Billroth could find only the following to say: 'Tumor formations in the nipple and areola are extremely rare; slowly progressive epithelial cancers are supposed to have been observed.' In the last two decades several authors have again resumed the discussions, for instance, Schield, Binaud et Braquehay. . . . but no one has included a complete casuistik." Rodman<sup>17</sup> and Handley<sup>8</sup> do not include this topic in their text books. Deaver and McFarland,<sup>2</sup> Dietrich and Frangenheim<sup>3</sup> devote separate chapters to the nipple, include much material, especially the former, but neither group completely elucidates the subject. v.Jaschke<sup>21</sup> is again deficient. Cheattle and Cutler<sup>1</sup> have spread relevant material throughout their book without drawing up a separate section. More recently, Geschickter<sup>7</sup> covers the subject with the enumeration of the warty nipple, intracystic papilloma, the pedunculated fibroma, neuroma, and leiomyoma.

Tumors of the nipple are uncommon

which probably exonerates the deficiency of textual descriptions. Lindfors<sup>15</sup> collected thirty-seven cases up to 1900: twenty-seven of the mamilla, ten of the areola; thirty in women, seven in men. Dietrich<sup>3</sup> compiled forty cases in 1901: six atheromas, six fibromas or fibroadenomas, three papillomas, five angiomas, three myomas, and fourteen cases of cancer. Deaver and McFarland<sup>2</sup> list a total of sixty-nine instances with nine varieties. MacCarty<sup>16</sup> surveyed 13,168 breasts and portions of breasts removed at the Mayo Clinic between 1907 to 1937 and was able to list thirteen cases of carcinoma of the nipple, two instances of accessory malignant nipple, and one fibroma of the nipple. The thirteen cancers of the nipple were predominately cases of Paget's disease. Our own case which suggested this report is the first encountered at our institution in six and one-half years during which time 333 tumors of the breast were examined (120 benign, 213 malignant).

Despite their infrequency mamillary tumors are no mere curiosity. Their pathology is variegated, their manifestations numerous and interesting. In Table 1 the different tumors of the nipple have been assembled. A report covering our case is justifiable because the tumors are bilateral, they are discoid in form, and one tumor is mixed consisting of fibromatous and papillomatous components. The tumors

\* From the Departments of Surgery and Pathology, Binghamton City Hospital.



TABLE I  
TUMORS OF THE NIPPLE

*Epithelial*

Benign

1. Papilloma<sup>3,4,15</sup>
2. Intracystic papilloma<sup>2,15</sup>
3. Intracanalicular (vestibular) papilloma<sup>10</sup>
4. Cystadenoma proliferum papillare<sup>15</sup>
5. Cystoma papillare<sup>15</sup>
6. Cysts<sup>2,3,15</sup>
  - a. epidermoid
  - b. atheromatous
  - c. nondescript

Malignant

7. Epithelioma<sup>1,2,3,15</sup>
  - a. squamous cell
  - b. transitional cell
  - c. ulcer rodens
8. Sebaceous gland adenocarcinoma<sup>1</sup>
9. Medullary fungus carcinoma<sup>15</sup>
10. Scirrhus carcinoma<sup>15</sup>
11. Intracanalicular<sup>1,2,15</sup>
  - a. duct cell
  - b. cylindrical cell
  - c. cystocarcinoma papillare
12. Paget's disease

*Non-epithelial*

Benign

13. Fibroma<sup>2,3,13,15</sup>
14. Fibroadenoma<sup>15</sup>
15. Angioma<sup>3,15</sup>
16. Leiomyoma<sup>2,3,14,15</sup>
  - angioma cavernosum
  - myoma telangiectoides (Virchow)
  - cystic myoma
17. Fibromyoma<sup>3,15</sup>
18. Neuroma (Stewart)<sup>19</sup>
19. Neurofibroma<sup>19</sup>
20. Pigmented nevus<sup>1,3</sup>
  - congenital moles

Malignant

21. Sarcoma (Klebs)<sup>2,3</sup>
22. Leiomyosarcoma<sup>3</sup>
23. Osteoid (osteogenic) sarcoma<sup>2</sup>
24. Melanoma<sup>2,3</sup>

*Miscellaneous-related*

25. Papilla verrucosa (warty nipple)<sup>21</sup>
26. Cornu cutaneum (Bauer)<sup>3</sup>
27. Keratosis areolaris naeviformis (Tissi)<sup>20</sup>
28. Dyskeratosis (Fischel-Jorstad)<sup>5</sup>
29. Acanthosis nigricans (Koch)<sup>12</sup>
30. Lymphoid hyperplasia in nipple (Kengyel)<sup>11</sup>

The "PEDUNCULATED TUMOR" of the nipple includes:

- a. Fibroma pendulum
- b. Fibroma pendulum bulbosum
- c. Fibroma pendulum papillomatousum
- d. Fibroadenoma pendulum
- e. Pedunculated sebaceous cyst
- f. Pedunculated papilloma
- g. Pedunculated angioma
- h. Pedunculated angioma cavernosum

listed in Table I are unilateral, none were complicated by any superimposed heterologous structure, and the most frequent form is the pedunculated tumor. Additionally, our fibroids of the nipples were accompanied by fibroids of the uterus.

CASE REPORT

D. W., was a forty-two year old, single, white, female nurse. Her medical and surgical histories were negative except for measles and pertussis as a child. Her family background was similarly devoid of any medical events. Gynecologically, she reported that the menarche started at sixteen. After an initial stage of dysmenorrhea in the first year, her menses were always normal in duration, intensity, and cycle. With her thirty-fourth year diminution of flow, shortening of the period, and some nervous depression set in. The patient's nipples were always somewhat prominent.

In November, of 1941, while sitting, the patient felt a mass in the left lower abdomen. This tumor gradually increased in size and soon was accompanied by frequency of urination and dysuria but no menstrual disturbances. About the same time of the palpation of her tumor in the abdomen, she noticed sensations of prickling and tingling in the left nipple. Soon thereafter, several prong-like projections appeared. The nipple gradually increased in size for about six months and became painful to touch. In January, 1943, she began to feel the same sensations in the right nipple. This became quite sensitive, especially premenstrual, developed a wart-like tumor that grew quickly and from which a thin, yellow fluid could be expressed. The nipple enlarged rapidly and its size soon overtook that of the left. In retrospect, the patient thought she could attribute the onset of the tumors to traumatism following a tight, pinching support. The breasts proper had remained about the same. At no time were constitutional symptoms noted.

The lady was an asthenically developed, slim individual of good health when admitted. She was still menstruating, felt comparatively well, and was gaining some weight. Pelvic examination determined the abdominal mass to be an enlarged fibroid uterus with lateral expansion and a globular prominence on the left side.



FIG. 1. A, the mam-  
millary tumors at  
the time of ad-  
mission.



FIG. 2. A, close-up  
of the right  
breast.

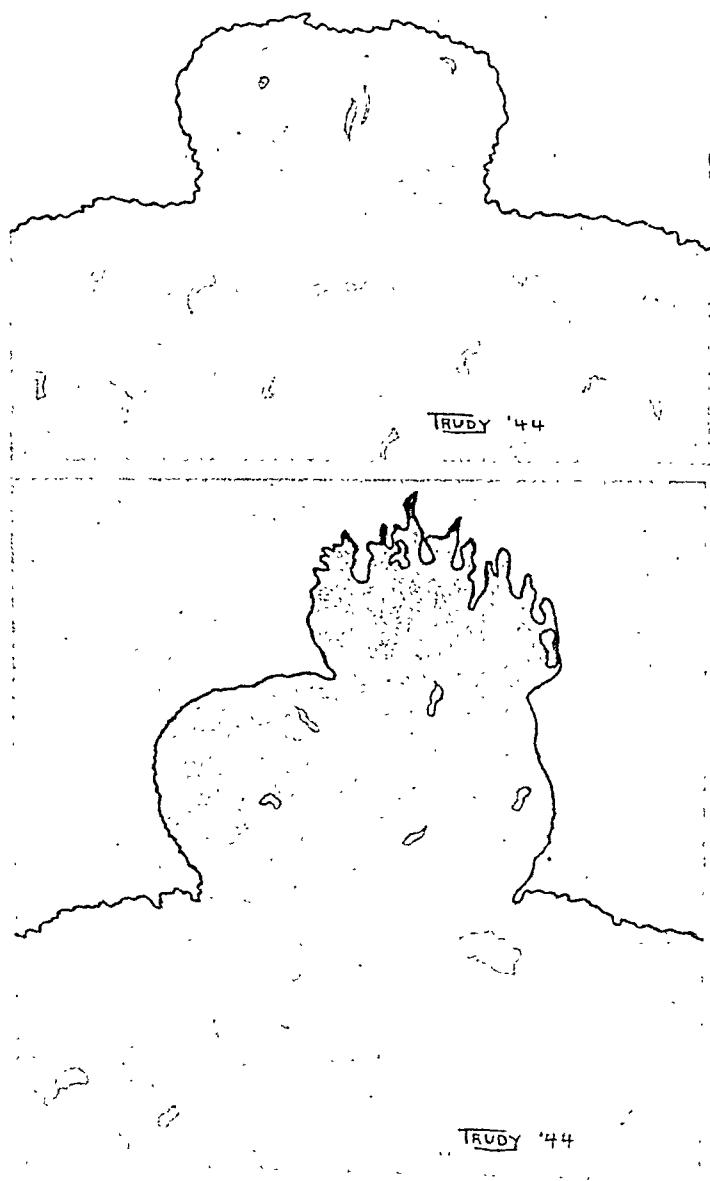


FIG 1. B, section of the  
left nipple (sche-  
matic).

FIG. 2. B, section of  
the right nipple  
(schematic).



The breasts were flaccid, of moderate size, their parenchyma dense and hyalinizing. The left nipple (Fig. 1) was replaced by a nummiform

In February, 1944, a hysterectomy was performed through a low, abdominal, midline incision by one of us (J. J. C.). Three weeks



FIG. 3. Fibroid uterus removed at the first operation.



FIG. 4. Microphotograph of the left nipple indicating fibromyomatous character.

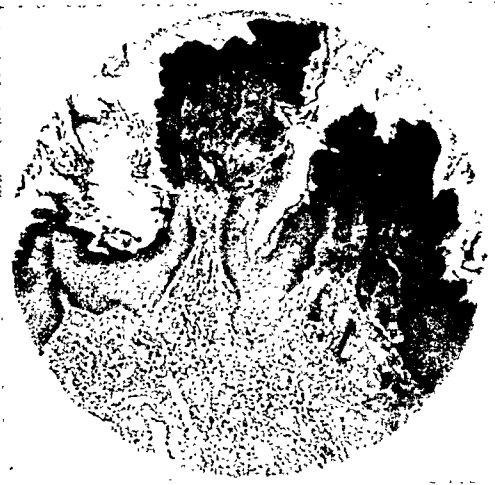


FIG. 5. Section of the papillomatous portion of the right nipple; marked chronic inflammation.

tumor 2.5 by 1.8 by 1.5 cm. set off from the breast by a short stalk. On the right side (Fig. 2) the nipple presented a discoid tumefaction, 2.8 by 3 by 2.6 cm., arising from a longer stalk and carrying a superimposed excrescence, 1.7 by 1.7 by 1.6 cm. In areas the latter was eroded and covered over with caked serum. The tumors were tender to palpation.

later, both breasts were removed by simple mastectomy. An elliptical incision was made transversely about each nipple. Skin and subcutaneous tissues were dissected to the outer margins of the breasts. The latter was freed from the underlying pectoral fascia and removed. The overlying skin was then anchored

to the pectoral fascia and redundant tissue excised. The wound was closed with silk sutures.

The uterus (Fig. 3) was a specimen of irregular outline and shape, without its cervix. Innumerable large and small fibroids protruded beyond the surface and measured from 1 to 11 cm. The perimetrium was thickened, smooth, and traversed by large veins. Much fibrous connective tissue surrounded the lower uterine segment. On sectioning the specimen, the fibroids were found to be present in all positions, but most of them occupied the left horn; none showed degenerative changes. The uterine cavity was narrow; the endometrium was thin, granular, and hemorrhagic. The right tube and ovary were attached. The former was normal to gross examination. The ovary measured 4.7 by 3 by 1.5 cm.; on section it revealed a cyst 2.7 cm. in diameter, filled with chocolate colored, congealed material and surrounded by a rim of brilliant yellow. Other residual lutein structures were also present.

Microscopically, the following was noted: Irregular endometrium in the late secretory phase but with tubular and cystically distended components; chronic inflammation, edema, and interstitial hemorrhage were also evident. Chronic endocervicitis; multiple large and small fibromyomas; fibrosis of the myometrium; a hemorrhagic corpus luteum cyst, multiple lutein bodies, and fibrosis of the ovary; hyperemia of the tube.

The nipples were described by Dr. V. W. Bergstrom as follows: "Sections from the breasts and the enlarged nipples show the latter to be composed of connective tissue stroma, muscles, and nerves. The stroma is very cellular, the fibrous connective tissue and the smooth muscle components are numerically and qualitatively increased. Dilated ducts are noted, many with papillary and bridge-like structures; these are accompanied by chronic inflammation. Some of the dilated ducts are rather tortuous; others are surrounded by loose, blue staining stroma like that of intralobular connective tissue. The epithelium of some of the ducts is flattened. One nipple has an attached, simple papilloma which manifests marked chronic inflammation.

"The nipple structure is sharply demarcated from the breast proper not by a capsule or a wall but by a definite change in histology. The

glandular parenchyma has been replaced by a very dense, almost acellular connective tissue within which are occasional small alveoli. The stroma is collagenous in nature and is in sharp contrast to the proliferative character of the nipple. Between the two an intervening zone containing loose, areolar tissue and fat cells is discernible. Sections stained by Van Gieson's method indicated the fibrous and smooth muscle constituents to be in about equal proportions."

It is proper to designate these nipple structures as tumors for the criteria of neoplasia are fulfilled: proliferative cellularity, hyperplasia, and hypertrophy. These features are exhibited by discrete sections of breasts which otherwise are undergoing retrogressive condensation of their parenchyma. The presence of the papilloma additionally confirms the tumor character of the nipples.

Figure 4 is a microphotograph of a portion of the left nipple to show its fibromyomatous nature; Figure 5 is a section of the papillomatous portion of the right nipple.

#### SUMMARY

1. The various tumors of the nipple have been compiled.
2. The case of a forty-two year old woman is described presenting bilateral nummiform fibromyomas of the nipples with a papilloma superimposed on the one side.
3. The fibroids of the nipples were accompanied by fibroids of the uterus.

#### REFERENCES

1. CHEATLE, G. L. and CUTLER, M. Tumors of the Breast. Philadelphia, 1931. Lippincott.
2. DEEVER, J. B. and McFARLAND, J. The Breast; Its Anomalies, Diseases, and Treatment. 1917. Philadelphia, Blakiston's.
3. DIETRICH, A. and FRANGENHEIM, P. Die Erkrankungen Der Brustdruse. Neue Deutsche Chirurgie-Kuttner, 1926 Bd. 35.
4. DUNKER, F. *Urol. & Cutan. Rev.*, 34: 378-380, 1930.
5. FISCHER, E. and JORSTAD, L. H. *Am. J. Surg.*, 11: 121-124, 1931.
6. FOWLER, R. H. *Med. Times*, 45: 195, 1917.
7. GESCHICKTER, C. F. Diseases of the Breast. Philadelphia, 1943. Lippincott.
8. HANDLEY, W. S. Cancer of the Breast, New York, 1922. Hoeber.

9. HERTZLER, A. E. *Surgical Pathology of Mammary Gland*. Philadelphia, 1933. Lippincott.
10. JUDD, E. S. *Lancet*, March 1, 1917.
11. KENGVEL, H. *Wien. med. Wchnschr.*, 79: 451, 1929.
12. KOCH, F. *Dermat. Wchnschr.*, 105: 1325, 1937.
13. LEE, T. H. *Chinese M. J.*, 50: 1664, 1936.
14. LIEBER, K. *Beitr. patb. Anat. u. allg. Path.*, 60: 449, 1915.
15. LINDFORS, A. O. *Monatschr. f. Geburtsb. u. Gynäk.*, 40: 763-779, 1900.
16. MACCARTY, W. C. *Proc. Staff Meet., Mayo Clin.*, 12: 817, 1937.
17. RODMAN, WM. L. *Diseases of the Breast*. Philadelphia, 1908. Blakiston.
18. SCHREINER, B. F. *Buff. M. J.*, 1913.
19. STEWART, F. W. *Surg. Clin. North America*, 13: 434-436, 1933.
20. TISSI, E. *Dermosifilografio*, 11: 469-477, 1936.
21. v. JASCHKE, R. TH. *Die Weibliche Brust*, in *Biologie und Pathologie des Weibes*. Halban-Seitz, Bd. V-2.

Acknowledgment to Paula Leonora for the photography (S.E.C.).



IN many instances cancer recurs on the site of original operation; this may be several years after the original treatment and is not due to metastasis, but probably is caused by some extensions which were not removed.

From "Metastases Medical and Surgical" by Malford W. Thewlis (Charlotte Medical Press).

# THE SURGICAL MANAGEMENT OF SUBSTERNAL AND INTRATHORACIC GOITER\*

ALEXANDER W. BLAIN, M.D.

Professor of Clinical Surgery, Wayne University

AND

ALBERT DEMATTEIS, M.D.

Resident in Surgery

DETROIT, MICHIGAN

MUCH has been written on substernal and intrathoracic goiter in recent years but the terminology has been indefinite. They are not synonymous terms but more recently the literature has been less confusing.

If we are able to adhere strictly to the term "intrathoracic goiter," we must then consider only those within the thoracic cage as true intrathoracic goiters. Those that extend through the thoracic aperture are considered as partial intrathoracic goiters. However, in reviewing the literature one notes that any goiterous tumor that extends into the thoracic cage and remains in that position even after coughing or swallowing or forced expiration is considered an intrathoracic goiter. If one adheres to this classification, the incidence of true intrathoracic goiter will be found to be less than 1 per cent. Partial intrathoracic goiter has a greater incidence, ranging from 25 to 30 per cent in the goiterous areas and 10 to 15 per cent in non-goiterous areas. Crile<sup>1</sup> reported an incidence of less than 1 per cent and Hunt<sup>2</sup> reported three cases of total intrathoracic goiter in a series of 651 cases. Curtis<sup>3</sup> reports the incidence of total intrathoracic goiter as between 1 and 2 per cent. In a series of 4,006 cases at the Mayo Clinic reported by Pemberton,<sup>4</sup> 0.6 per cent were intrathoracic and 13.5 per cent partial intrathoracic goiters.

The ratio of intrathoracic goiter in male and female remains the same, about one to five as any adenomatous goiter. The age incidence averages at about forty-five years. It is rarely found below the age of twenty, but is not infrequent after sixty-five. One of our oldest operative patients

was eighty-three years, with a large partial intrathoracic goiter.

Intrathoracic goiters are, as Lahey<sup>5</sup> states, adenomas which developed from a small adenoma in the lower pole of either lobe of the thyroid. Lahey, in more than 14,000 thyroidectomies, has never seen an intrathorax primary hyperthyroid with true hyperplasia.

## ANATOMICAL CONSIDERATIONS

The descent of the enlarging adenoma into the thorax is aided by the upward and downward motion of the thyroid in the act of swallowing. Its downward growth, below the sternum, is a natural course since it is the site of least resistance. On its anterior surface it encounters great resistance from the "ribbon" muscles, namely, the sternohyoid, sternothyroid and omohyoid; and also from the sternocleidomastoid. Its descent downward is only resisted by the deeper fascial planes, but these are carried downward through the thoracic aperture and into the superior mediastinum. However, the thoracic aperture is narrow and in order for the adenomas to become larger it must descend deeper into the thorax. In doing so it increases its transverse diameter, a point which is of great importance when it is removed. The depth it may attain is, of course, variable but several cases are reported in which it has almost reached the level of the arch of the aorta. What happens to the trachea is dependent upon the size of the gland. The illustration (Fig. 1) shows the distortion and lateral compression of the trachea. Here one can see how the trachea is distorted and how the lumen is constricted. This accounts for the

\*From the Department of Surgery, Alexander Blain Hospital.

most prominent symptoms of substernal and intrathoracic goiter, namely, dyspnea and choking sensation. It also brings out

venous return of the superior vena cava. The other symptoms of thyroid disease,<sup>7</sup> such as nervousness, tachycardia and

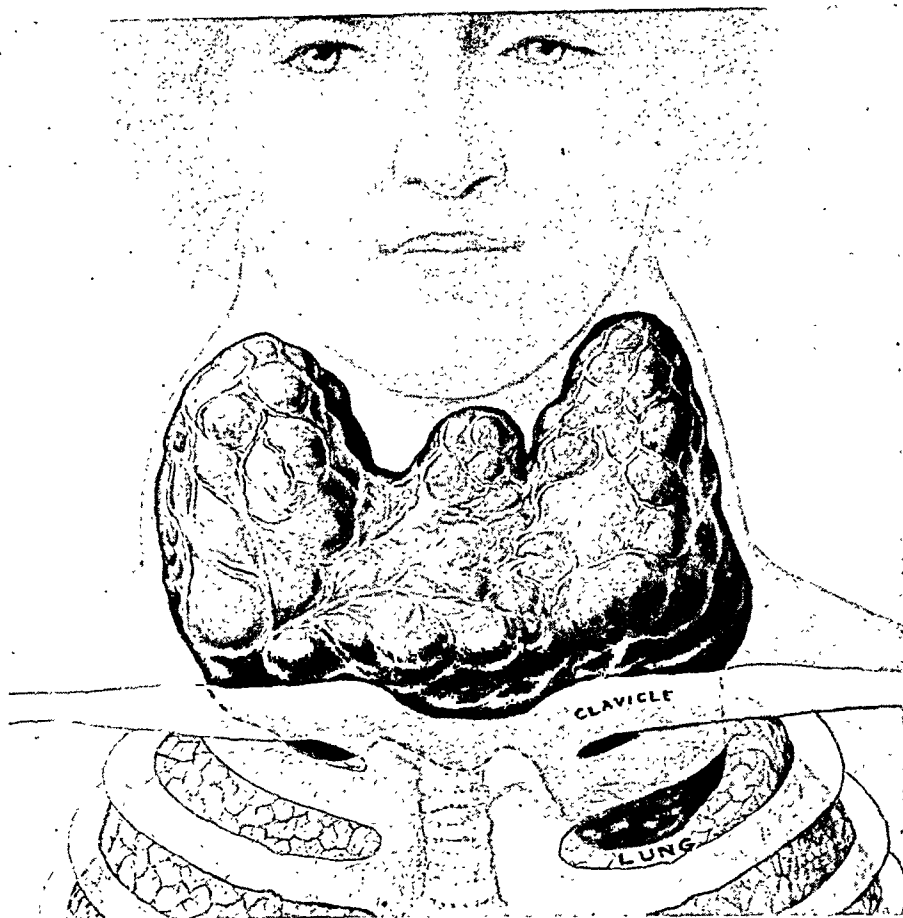


FIG. 1. Partially sub-sternal goiter.

one point in the diagnosis that has been stressed by Lahey, which is the shifting of the thyroid cartilage away from the midline. The result of pressure exerted by the mass on the trachea produces the most serious and alarming symptom. Also, it causes the choice of anesthesia to be a problem which must be carefully considered.

#### SYMPTOMS

Symptoms of intrathoracic thyroid are dyspnea due to distortion and compression of the trachea; dysphagia due to direct pressure of the goiter upon the esophagus; edema of the neck and head is sometimes present in large intrathoracic goiters due to the pressure of the gland upon the

tremor are present to a varying degree, depending upon the amount of toxicity present and, although Lahey has stated that few, if any, of these goiters are truly primary hyperthyroid goiters, a certain amount of hyperthyroidism is present in a surprisingly high number of cases. This, we believe, is evidenced by the high basal metabolism rate, tachycardia and tremor. It is true that all of the complete intrathoracic goiters do not present toxic symptoms but certainly a great number of the partial or incomplete intrathoracic goiters show signs of hyperthyroidism. Although the dysphagia and dyspnea may be present for a number of years they do not become severe until the last few months of the



disease when the symptoms become so alarming that the patient seeks the aid of the surgeon.

mucus collecting in the trachea, the patient is then free to cough and remove the mucus. It will also serve as a guide in

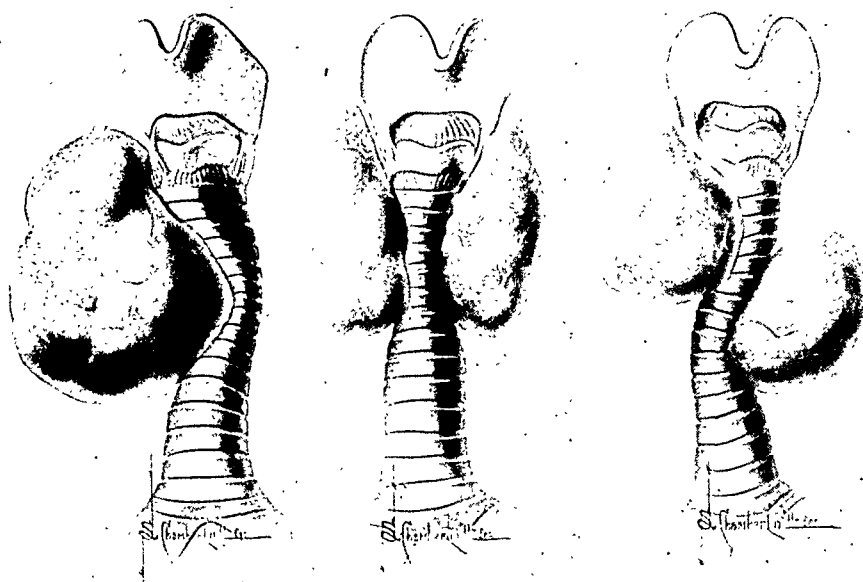


FIG. 2. Tracheal compression due to tumor masses at various levels.

#### ANESTHESIA

The type of anesthesia most commonly employed in this clinic is local infiltration anesthesia. This has been satisfactory in practically all of our cases. However, when the symptoms due to distortion of the trachea are present one must seriously consider the use of an intratracheal catheter of the hard rubber type with ether as one of the inhalation anesthetics. This will allow more manipulation of the tumor mass as it is being removed without further compression of the trachea and the fear of mucus secretion can be handled quite easily. Many clinics use cervical block anesthesia with excellent results,<sup>9</sup> while some still use nitrous oxide and oxygen.<sup>10</sup> Ethylene cyclopropane is also an excellent anesthesia, but the advantages of local infiltration or cervical block far outweigh the general type of anesthesia in that one has full control of the patient during the operation. Should any difficulty arise with

determining the status of the recurrent laryngeal nerve. When using nitrous oxide and oxygen on a patient who has considerable narrowing of the trachea, difficulty is encountered if the constriction does not permit enough oxygen to be carried through into the lungs. Lahey has advised, in these cases, the use of an oxygen-helium mixture. The helium is a good vehicle and the mixture is of much lower molecular weight and can be transported through the constricted trachea much easier.

#### TECHNIC

The technic used in the removal of such tumors is about the same as that advised by other men, such as Lahey, Crile and Hunt. A low collar incision is made and adequate exposure is essential. The ribbon muscles are transversely severed and retracted away from the field of operation. Crile did not like the idea of cutting the muscles, but most others, as well as we in

this clinic, usually do so and the post-operative cosmetic results are comparable to those in which the muscles have not been

the middle thyroid vein. If much capillary oozing is anticipated preoperatively oxalic acid is used as an adjunct to hemostasis.<sup>12</sup>

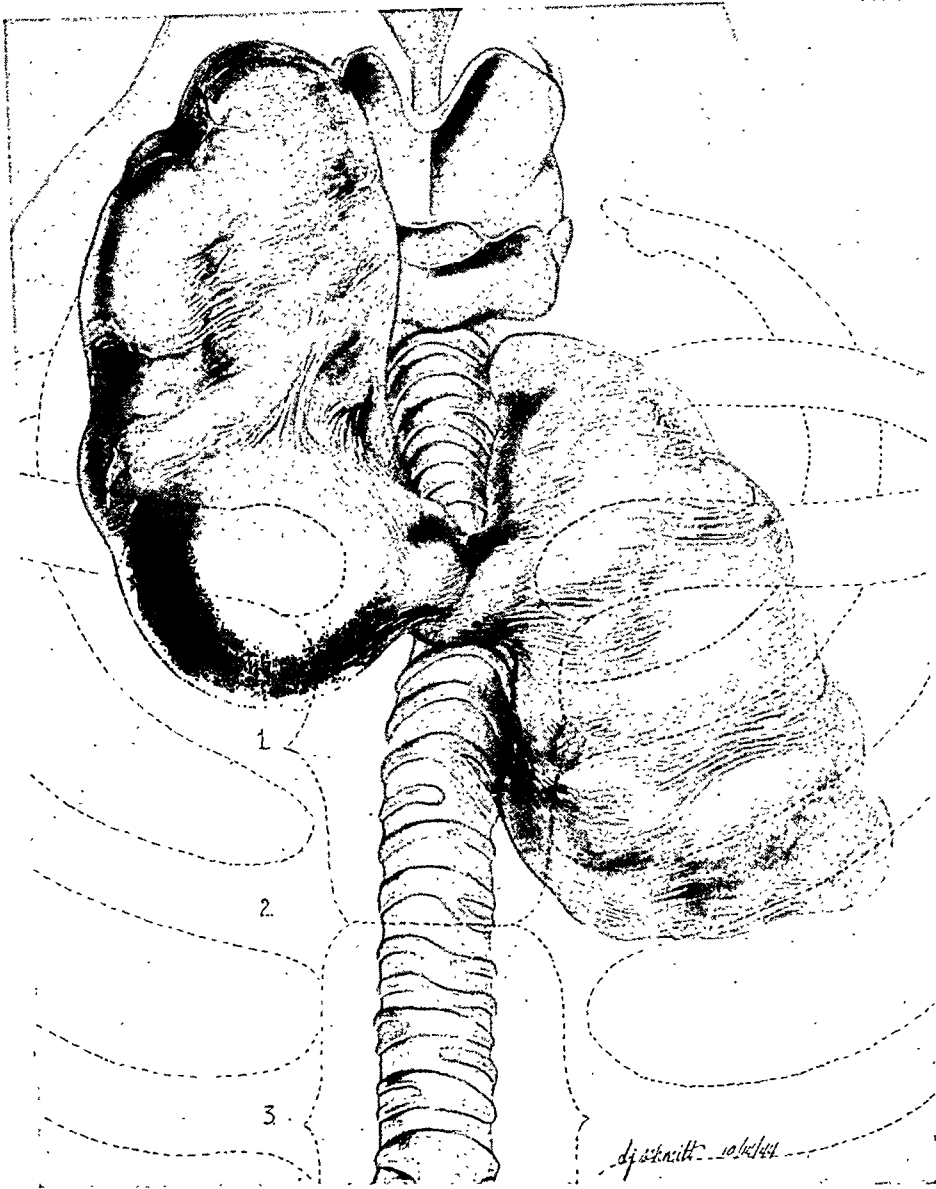


FIG. 3. Sub-sternal goiter (G. B., age eighty, July, 1944).

severed. One must remember that the blood supply to the thyroid gland comes from the superior and inferior thyroid arteries. The venous return is through the superior, middle and inferior thyroid veins. Therefore, if ligation is first made on the superior thyroid artery and vein, relatively little bleeding will be encountered until the dissection is carried on to the level of

The gland is then brought forward, exposing these veins, which are clamped and ligated, thus permitting greater traction on the gland. The procedure in the removal of the gland should be carried out within its fibrous capsule. This will prevent injury to the recurrent laryngeal nerve, which lies just below the capsule and hugs the trachea. The intrathoracic portion,

which is the most difficult to remove, can be approached by one or two methods. Lahey uses the method he devised some

and thoracic fascia. The finger is brought down to the base of the gland if possible. As he makes traction with the Lahey clamp



FIG. 4. X-ray (retouched) showing compression of trachea.

years ago in which he inserts the index finger posterior to the adenoma, passing it within the capsule and the loose intracellular tissue lying adjacent to the cervical

from above, he also forces the gland upward through the thoracic aperture with his finger. In doing so the inferior thyroid artery can be handled in one of two ways,

i.e., ligating it as it is exposed when delivering the tumor, or, at the beginning of the procedure (instead of passing the finger

the tumor is delivered, there will be a sudden release of negative pressure within the cavity occupied by the gland, causing



FIG. 5. X-ray (retouched) showing trachea after removal of thyroid tumor.

down to the base of the gland), bringing the finger forward and exposing the artery. This latter method is perhaps not the safest method but can be carried out. As

a re-expansion and shifting of the mediastinum back into its normal position. However, a small cavity will remain in the upper mediastinum and this should be

packed with dry gauze, not only to permit hemostasis but also to serve as a drain, thereby keeping the cavity dry. Another

up the glandular tissue and removing it, thereby reducing the volume of the tumor and allowing it to be delivered quite easily.

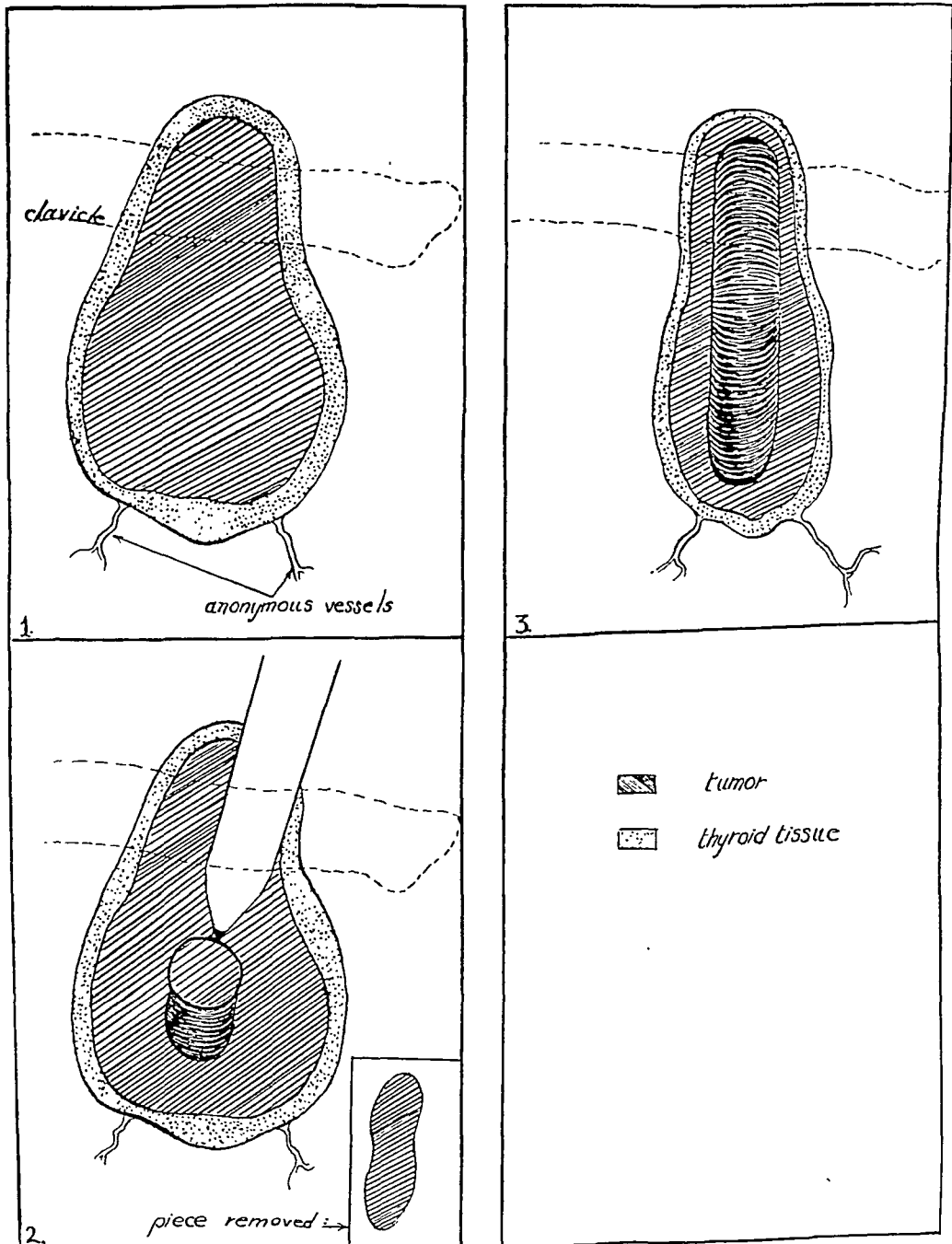


FIG. 6. Morcellation with radio knife.

method, which is also advised by Lahey, and which is used to great advantage in the true intrathoracic goiter, is passing the finger directly into the gland, breaking

A method that is sometimes used in this clinic is morcellation of the gland, thereby reducing its size and removing the adenoma in piece-meal fashion. The vessels are

ligated as approached. This method has one advantage of importance. Though the gland is removed in pieces from its thoracic site, bleeding is more easily controlled and the danger of breaking through adhesions containing blood vessels when passing the finger around the gland is greatly minimized. Bleeding here is quite serious and hard to manage as one can imagine, and, therefore, morcellation may avoid this danger. The desire of a surgeon to remove a tumor intact as a specimen is great, but when morcellation makes the removal much easier then it should be done. It is far more desirable to make the procedure life-saving to the patient than to save a good specimen. When one uses one of the latter two methods he must be extremely careful in not allowing any of the glandular tissue to remain within the thoracic cavity, since this is an excellent medium for infection in causing mediastinitis. The drains mentioned previously are not removed in two days but are gradually taken out over a period of five to eight days. In doing so the accumulation of serum which often accompanies following the removal of such tumors will be avoided.

#### CONCLUSIONS

1. A distinction in nomenclature should be drawn between substernal and intrathoracic goiter.
2. Morcellation of the tumor facilitates the removal and renders the procedure safe.
3. As in all goiter operations the finger should not be swept around the gland but the gland should be placed under traction with forceps. In this way the operation is not a blind operation and if the smaller

organ is removed gradually anomalous vessels can be observed and ligated.

4. Morcellation can be accomplished by removing part or all of the tumor within the gland by blunt dissection. In some cases the radio knife can be used to advantage—gradually cutting away the center of the mass with the coagulating current.

5. The objection to morcellation, except in malignancy,<sup>13</sup> is answered by the statement that the operation is designed to cure the patient—not to save a good pathological specimen.

#### REFERENCES

1. CRILE, GEORGE, JR. Tumors of lateral aberrant thyroid origin. *J. A. M. A.*, 113: 1094-1097, 1939.
2. HUNT, CLAUDE J. The diagnosis and management of partial and total intrathoracic goiter. *Tr. West. Surg. Ass.*, 465-474, 1939.
3. CURTIS, G. M. Intrathoracic goiter. *J. A. M. A.*, 96: 737-41, 1931.
4. PEMBERTON, J. DEJ. Surgery of substernal and intrathoracic goiters. *Arch. Surg.*, 11: 1-20, 1921.
5. LAHEY, FRANK H. Intrathoracic goiter. *J. A. M. A.*, 113: 1098-1104, 1939.
6. BLAIN, ALEXANDER W. Embryology, anatomy, histology and chemistry of the thyroid gland. *Internat. J. Surg.*, 29: 117-119, 1916.
7. BLAIN, ALEXANDER W. Diseases of the thyroid gland. *Internat. J. Surg.*, 29: 46-47, 1916.
8. BLAIN, ALEXANDER W. A clinical study of general anesthesia. *New York M. J.*, May 9, 1908.
9. JACKSON, ARNOLD S. Intrathoracic goiter. *Jackson Clin. Bull.*, 6: 43-51, 1944.
10. BLAIN, ALEXANDER W. Nitrous-oxide-oxygen anesthesia in major surgery. *J. Mich. State Med. Soc.*, November, 1922.
11. BLAIN, ALEXANDER W. The surgical aspects of goiter with special reference to pressure symptoms. *Internat. J. Surg.*, 24: 43-49, 1911.
12. BLAIN, ALEXANDER W. and CAMPBELL, KENNETH N. Hemostatic effect of oxalic acid; clinical and experimental results, with a review of the literature. *Arch. Surg.*, 44: 1117-1125, 1942.
13. BLAIN, ALEXANDER W. Malignant tumors of the thyroid gland. *Internat. J. Surg.*, 26: 166-169, 1913.



# SKIN GRAFTING IN MORIBUND BURNED PATIENTS

LESTER W. EISENSTODT, M.D.

Assistant Plastic Surgeon, Newark Beth Israel Hospital

NEWARK, NEW JERSEY

**I**F a burn of the skin results in its complete destruction over an extensive area, progressive debility occurs, which is often difficult to control by medical therapy alone. In order to preserve life, it is imperative to resurface the exposed areas as early as possible. In addition to aiding the physiochemical processes of the body, early skin grafting impedes the rapid progressing inanition. If some of the deep epithelial elements are preserved, a superficial third degree burn may epithelialize rapidly and quite satisfactorily without the use of a skin graft. Undue conservatism and delay in anticipating spontaneous epithelialization, however, is wrong as extensive deep burned areas sometimes resist all efforts to stimulate epithelialization.

Severely burned patients should be isolated and treated in separate rooms as an obnoxious penetrating odor is emitted. In spite of the fetid odor, the dressings are not changed more often than every seven to ten days. An oil skin covering over the bulky pressure dressing helps to confine the malodor. Antiseptic deodorants are also useful. During the summer months, maggots may be found on the raw surfaces but are not detrimental.

The patient's general condition must be treated along with the local lesion. In the early stages of an extensive burn after the primary débridement, the entire therapy is directed toward measures for improving the state of the patient. There is a progressive depletion of the hemoglobin and plasma proteins. Hypoproteinemia and secondary anemia frequently develop despite all therapy. Vast amounts of protein are lost in the exudate from the burn surface and by the excretion of nitrogen in the urine. The protein loss and progres-

sive anemia can be better controlled by pressure dressings and the early application of skin grafts whether homogenous or autogenous.

With the advent of the dermatome, the problem of resurfacing large defects has been considerably facilitated. Almost any part of the body may be used as a donor site, viz, arms, chest, abdomen, back, buttocks, thighs and legs. If only a limited amount of skin is available due to the vastness of a burn, the donor area may be reused or a homograft applied. If Thiersch or thin split-thickness grafts are employed, the sub-epithelial structures of the donor site are preserved and regeneration occurs. The donor site will be available for reoperation in about five weeks. Full thickness free grafts are not used in extensive burns due to the resulting donor defects and the long period required for their healing. Besides, the field in these cases is dirty and there is little chance for a thick graft to take.

Early grafting is highly desirable. The optimum time is inconstant and varies with each case. When all the devitalized tissue has been removed and the period of shock terminated, grafting should be carried out. The longer one procrastinates, the more progressive the anemia, hypoproteinemia and resulting debility. In extensive deep burns with marked infection, the wound may not be ready for grafting for six to eight weeks after the injury. In the presence of frank pus, grafting is never performed. Severely infected areas are surgically prepared by a daily change of dressing with the application of a thin coating of sulfathiazole powder, and a continuous wet pressure dressing of 1:3300 aqueous azochloramide. As soon as the area has assumed a clear

healthy appearance, grafting should be started even though tissue culture may show the presence of pyogenic organisms.

thickness dermatome grafts will take readily despite these adverse conditions.

A quick efficient method of saving life

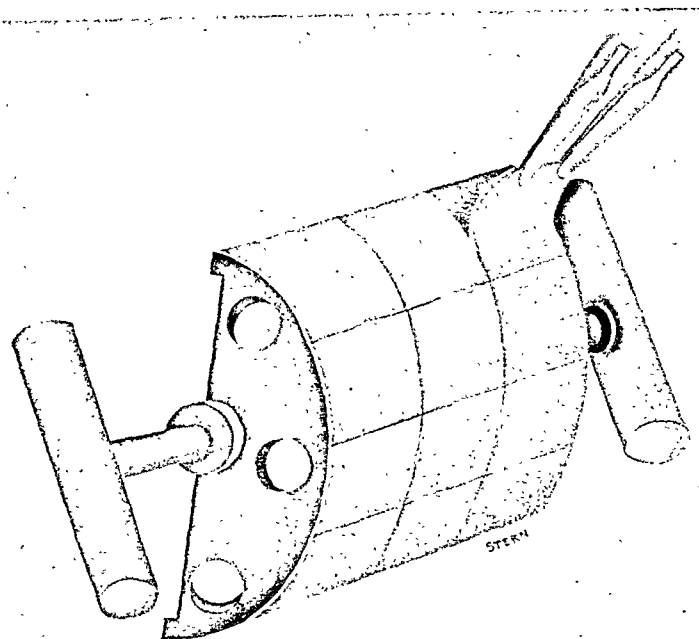


FIG. 1. Thin split-thickness graft patterned into squares on the dermatome drum.

If the operation has been delayed, soft friable exuberant granulations are present covered by a moderate granular discharge. This is no contraindication to skin grafting and the granulations are merely shaved down to their firm, yellowish base and the grafts applied.

The patient should be in the best possible physical condition before grafting. If a burn is extensive, however, the patient's state is usually poor. Anemia and hypoproteinemia are present and are not ideal conditions for skin grafting. Most surgeons tend to defer operation until the plasma protein level approaches normal and the hemoglobin is above 70 per cent. Unfortunately, it is often impossible to attain these levels in extensive burns despite repeated daily intravenous injections of amino acids and whole blood, liver, vitamin and iron therapy, and a high protein and high caloric diet. Anemia and hypoproteinemia are no contraindication to skin grafting when grafting is deemed necessary. In most instances, thin split-

in extensive burns where the quantity of donor skin is limited, is to cut thin split-thickness dermatome grafts dividing them into squares. (Fig. 1.) These are then placed checker-board fashion on the raw surfaces. Poth<sup>29</sup> cuts his grafts by the dermatome, backs them with adhesive and then cuts them into squares or strips. Gabarro<sup>15</sup> applies the dermatome graft to stiff sticky paper and then patterns it into squares. Hardy<sup>18</sup> and McNichol use pliofilm cemented to the drum and Jenney<sup>21</sup> employs cotton bobbins in a similar fashion. If very small squares are employed, the above technics are preferable. If larger squares are used, the direct transfer from drum to recipient site is more advantageous. After an interval of ten days, one may observe the circumferential proliferation of these grafts. Epithelium has been added to the denuded areas which grows in all directions until the spaces between the squares have been covered. A stabile pliable covering is formed. Checker-board grafts are used on large



exposed flat surfaces and are not employed over joints. Large free grafts are more suitable for the latter. Contractures are prevented by immobilizing the joint in optimum position after the application of a large free graft. If a bone is exposed, the cortex is drilled to produce granulations upon which a graft may be applied after the granulations have formed.

The patient is prepared, draped, and the cement is applied to the donor areas and dermatomes. When the cement is dry, gas and oxygen are administered and the grafts cut. The anesthesia is then discontinued. Two to four drums of skin may be cut in a few minutes with little or no shock to the patient. The grafts are patterned into squares on the dermatome simply by incising them with the scalpel. They are then placed checker-board style on the recipient site. When a square is lifted from the dermatome it has a tendency to curl. However, once applied to the granulating area this tendency disappears and the graft adheres to the surface. Suturing is unnecessary. With the application of a compression dressing, a complete take is almost assured. A vaseline gauze occlusion dressing is preferable to a dry compression bandage as it does not adhere to the graft when redressing the patient. The dressings are almost painless and only a minimum of bleeding ensues from the granulating non-grafted areas. Excessive oozing is undesirable as an anemia is already present. The bleeding which occurs from granulating areas at each change of dressing may be excessive unless a greasy non-adherent substance is used.

It appears logical to assume that the cutting of several grafts from a toxic burn patient would greatly increase the exposed body surface resulting in a more severe toxemia. Clinical observation has shown this not to be the case. Severely burned patients cachectic from extensive exposed surfaces have shown gratifying improvement following the third day of the application of grafts. The total denuded surface area has not been materially increased

since the recipient site covered by these grafts is almost equal in size to the donor area. If a free graft is successful, it is fixed and has taken at the end of forty-eight hours. An exudate no longer forms so that the proteins are conserved. Patients show subjective and objective improvement. Subjectively they feel and look better and their appetites increase. Objective improvement is manifested by repeated blood counts. The hemoglobin and erythrocytes are not destroyed as rapidly as previous to the application of the grafts. The controversy as to whether a toxin from the burn surface or septic absorption is the cause for the anemia and hypoproteinemia has not been established as yet. However, spectacular improvement is noted soon after the application of the grafts.

Split-thickness dermatome squares are superior to pinch grafts. The operation is performed more quickly and is less tedious. The grafts are of uniform thickness and a complete take is almost assured. They have been found to take well in contaminated and even in moderately infected areas. They have even been successful in moribund patients with the hemoglobin as low as 30 per cent, a plasma protein level of 5, in the presence of infection. Although the cosmetic result of checker-board grafting leaves much to be desired, they are of advantage in requiring less skin, taking better and resurfacing large areas in a short time.

#### CASE REPORT

R. J., age forty, colored, a truck driver, ran out of gas on April 13, 1944. He purchased some, filled the gas tank and was pouring the remainder into the carburetor when the gasoline ignited and his right trouser leg caught fire. The flames shot up the right leg, across his abdomen, and down the opposite leg. The fire was extinguished by rolling the patient on the ground and he was admitted to the Beth Israel Hospital. Admitting examination revealed a well developed husky colored male not in apparent shock. His blood pressure was 130/100. The patient presented burns of both

legs, buttocks, penis, scrotum, lower abdomen and arms. These were believed to be second and third degree.

A primary cleansing débridement was performed by Dr. Meyer J. Cohen after scrubbing both lower extremities for ten minutes with soap, water, and saline. Vaseline gauze and a pressure bandage were applied. Laboratory examination revealed leucocytes 22,400, hemoglobin 140 per cent, and erythrocytes 5,960,000, a considerable hemoconcentration. The blood chloride level was 422, and the plasma proteins 6.1; 2,000 cc. of 5 per cent glucose in saline, 500 cc. of plasma, gas gangrene and tetanus anti-toxin sera were administered. Fluids were forced and opiates given to control pain. Due to the leucocytosis, sulfathiazole (1 Gm.) every four hours was given.

The patient's temperature remained normal and his condition apparently satisfactory until May 3rd (twenty days after admission), when the temperature suddenly rose to 102°F. The patient became irrational. The legs were redressed and examination revealed a severe cellulitis. A partial débridement of the whole skin was performed. The next day, further débridement was carried out, and the following day, May 5th, extensive débridement was performed completely removing the entire skin of both legs. A marked amount of free pus was found subcutaneously and between the layers of the muscles of the legs. Incisions were made in the fascial planes to allow the pus to drain. The temperature continued to spike to 102°F. despite adequate drainage. On May 7th, the temperature suddenly dropped from 102 to 96.4°F. The patient became pale, listless, and irrational, his pulse feeble, and his skin cold and clammy. He was apparently dying. Caffeine sodium benzoate, strychnine, coramine, an infusion and a blood transfusion were administered. The patient rallied and his condition greatly improved. On May 8th, continuous 1:3300 aqueous azochloramide wet dressings were started. On May 25th, the left tendon Achilles and the peronei muscles of both legs sloughed away. The anterior surface of the right patella and the anteromedial surface of both tibias were exposed. A large decubitus ulcer had formed over the sacrum and coccyx in spite of daily alcohol massages and a rubber nursing ring. Another large ulcer appeared over the right hip joint.

Additional therapy which had been admin-

istered since admission were daily intravenous injections of amino acids, a high protein and high caloric diet and repeated blood transfusions. The patient also received 6 tablets of feosol, 6 capsules of vitamin B complex and 200 mg. of ascorbic acid daily. Despite all medical therapy, a blood count on June 5th showed leucocytes 12,900, hemoglobin 30 per cent, and erythrocytes 2,010,000. Multiple cultures taken from both legs revealed *Bacillus proteus*, hemolytic streptococci and *Staphylococcus albus*. Blood cultures were negative, Wassermann and Kline tests were also negative.

On June 8th, fifty-seven days after admission, in spite of the positive tissue culture, a plasma protein level of 5, a hemoglobin of 30 per cent and a loss of weight of approximately 60 pounds, it was decided to attempt skin grafting. Medical therapy alone could not control the rapidly progressive depletion of the hemoglobin and the proteins. The operative report of June 9, 1944, is as follows:

The defect consisted of third and fourth degree burns of the whole of both legs, both buttocks, and lower abdomen. The second degree burns of the penis, scrotum, and arms had healed completely. The anteromedial surfaces of both tibias and the right patella were exposed.

The patient's general debility prevented any extensive surgery so that it was deemed advisable to cut one graft administering only small amounts of gas and oxygen while cutting the graft. A dermatome graft .010 inch thick was cut from the abdomen and trimmed into squares. These were placed checker-board style on the ventral surface of the right thigh from below the inguinal ligament to an area above the knee joint. The right tibia was drilled to produce granulations. Sulfathiazole powder, vaseline gauze and pressure dressings were applied both to the legs and donor abdominal site.

The dermatome squares of the previous operation took completely. On June 23rd (fourteen days later), the patient was again brought to the operating room. Three .012 inch dermatome grafts were cut from the upper abdomen and chest wall. Two of these grafts were modeled around the right knee except in the region of the exposed patella. The third graft was cut into squares and placed checker-board fashion down the ventral surfaces of the right and left legs on either side of the exposed

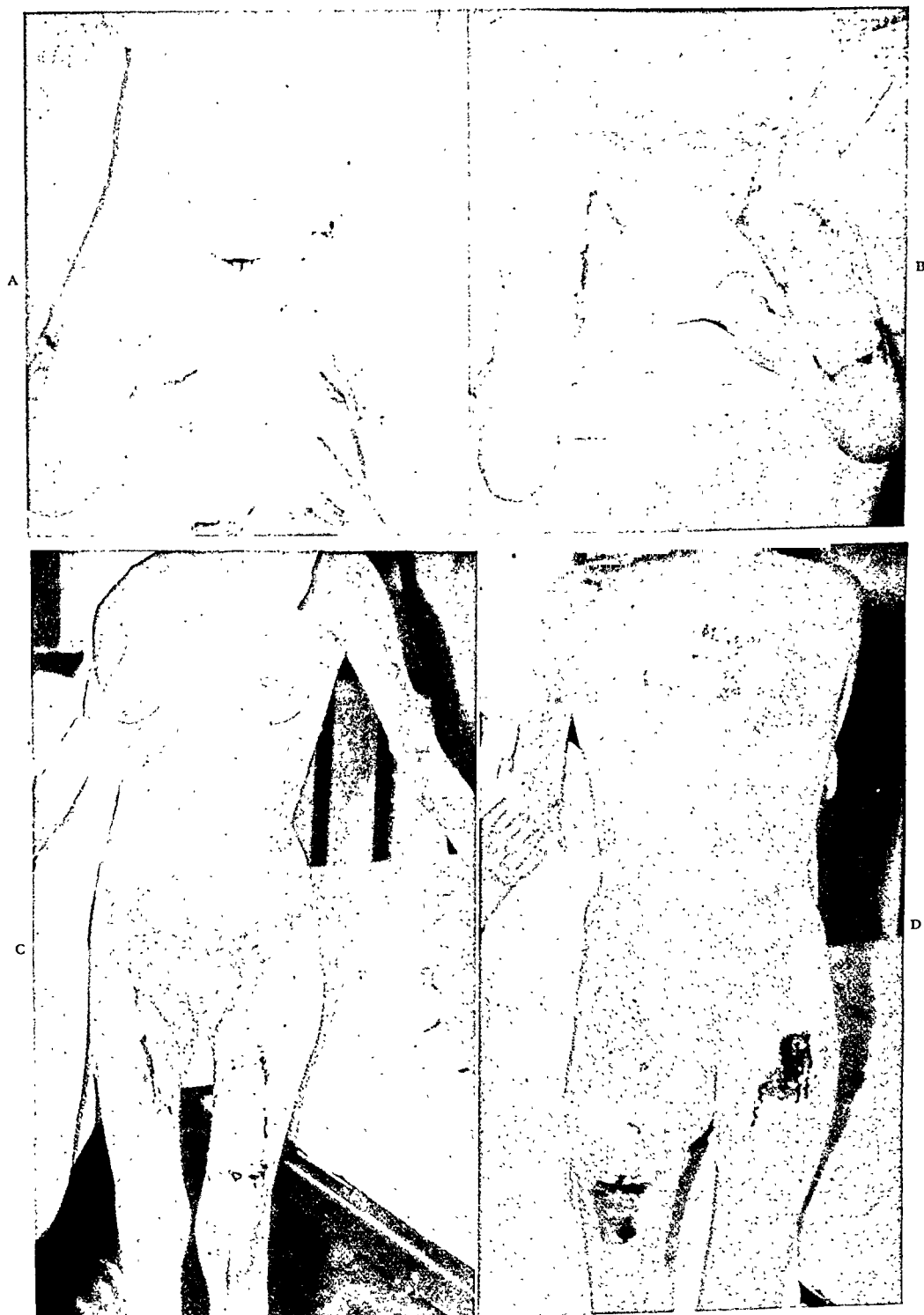


FIG. 2. A, preoperative photograph of extensive third degree alcohol burn of both thighs and lower abdomen. B, postoperative result two weeks after grafting. Three .016 inch dermatome grafts patterned to match the defect and sutured into place. C, postoperative photograph showing grafted left arm, grafted lower abdomen, and grafted thighs. The other burned portions of the abdomen, breasts, and chest healed spontaneously. Three .016 inch dermatome grafts patterned and applied to the left arm after releasing scar contracture. Three .016 inch dermatome grafts patterned and applied to both thighs and lower abdomen. D, donor sites. Three dermatome grafts taken from back five weeks previous to photograph. Three dermatome grafts taken from buttocks two weeks previous to photograph.

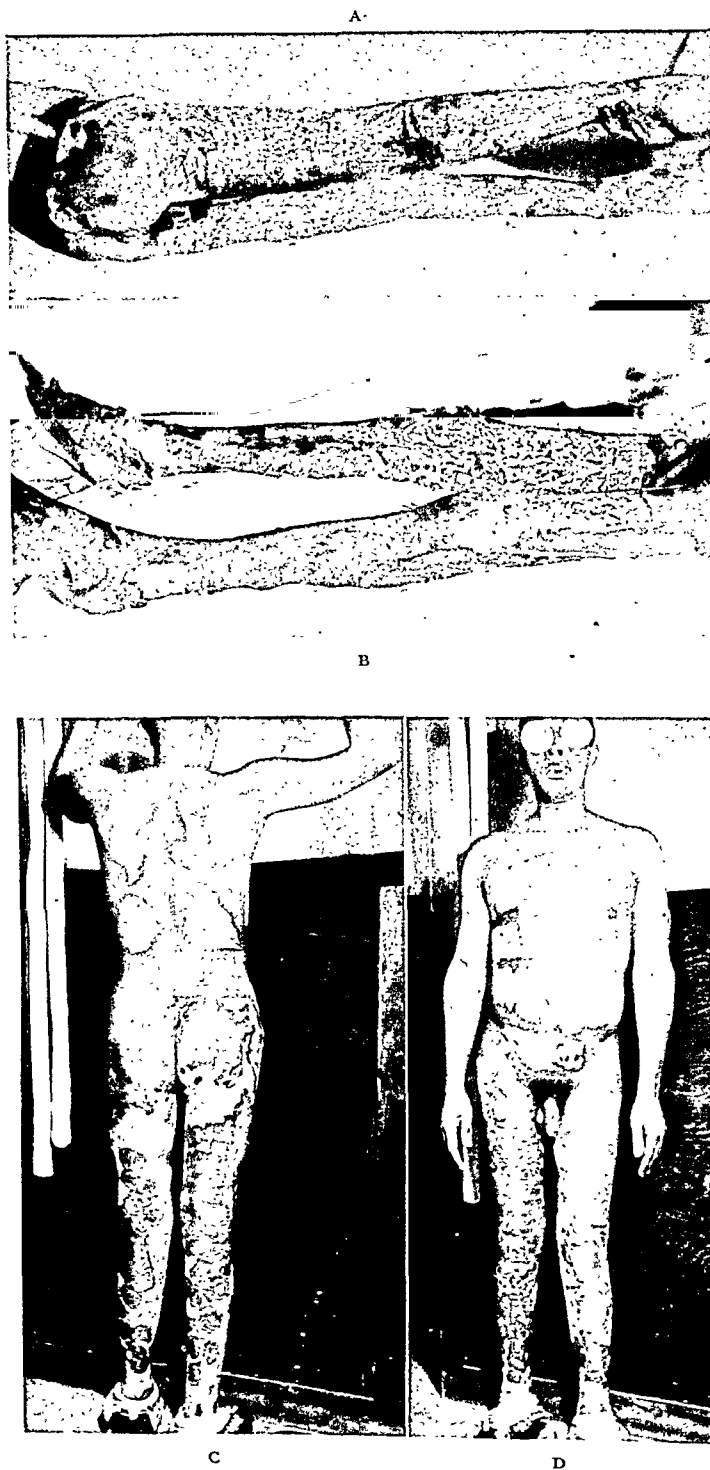


FIG. 3. A and B, preoperative photographs of extensively burned legs. C and D, postoperative photographs three and one-half months after start of grafting.

tibias. The patella was drilled to produce granulations.

Three days after this operation the patient's general condition improved greatly. At the next dressing, it was found that the ventral surface of the left thigh down to the knee had epithelialized spontaneously. On July 14th (three weeks later), the third plastic operation was performed.

board grafts had progressed rapidly and satisfactorily. The lower one-third of both tibias were still exposed. The fourth plastic operation was performed two weeks later on July 28th.

The anteromedial surface of the left tibia was drilled through the cortex to produce granulations. Two .012 inch dermatome grafts were cut from the right side of the chest. These grafts were patterned to match the remaining

TABLE I  
SUMMARY OF OPERATIONS AND SELECTED PERTINENT BLOOD COUNTS

	4/14	4/18	4/20	4/27	5/8	5/16	6.5	6/9	6/10	6/13	6/17
Hemoglobin.....	140%	101%	82%	68%	64%	72%	30%		39%	51%	39%
R.B.C.'s (Millions).....	5, 9	4, 8	4, 3	3, 4	2, 6	3, 6	2, 0		2, 1	2, 7	1, 7
W.B.C.'s (Thousands).....	22	11	18	20	20	8	12		10		
Operation.....								One drum .010 in. thick			
Take.....								Complete			

	6/23	6/24	7/1	7/8	7/14	7/15	7/19	7/23	7/28	7/29	8/4
Hemoglobin.....		40%	63%	59%		51%	45%	42%		50%	66%
R.B.C.'s (Millions).....		2, 8	3, 7	2, 9							
W.B.C.'s (Thousands).....											
Operation.....	Three drums .012 in. thick				Four drums .012 in. thick				Two drums .012 in. thick		
Take.....	Complete				Complete				Complete	Last Blood Transfusion	

	8/7	8/18	8/23	8/26	8/30	9/8	9/16	10/5	10/27	11/16
Hemoglobin.....	74%	66%		63%	64%	62%	70%	78%	82%	94%
R.B.C.'s (Millions).....										
W.B.C.'s (Thousands).....										
Operation.....			Two drums .016 in. thick							
Take.....			Complete							

The patient was emaciated and his ribs and vertebral column were very prominent making it difficult to cut the grafts from the back. Four dermatome grafts .012 inch thick were cut from the back. Two of these grafts were sutured over both popliteal fossae. The remaining two grafts were cut into squares and placed checker-board style over the dorsal surface of both legs and thighs.

The grafts from the previous operations took completely. Epithelialization from the checker-

defects and were sutured to the lateral side of the right leg and upper medial side of the left leg.

By August 22nd, the whole of both legs were covered except for small areas of the exposed tibias and the ankles. Exuberant granulations were present around both ankles. The patient was operated upon for the fifth time.

The exposed areas of both tibias were drilled through the cortex of the bone. Exuberant granulations around both ankles were shaved

down. Two split-thickness dermatome grafts .016 inch were cut from the lower abdomen. These grafts consisted of regenerated skin following the previous operations. The grafts were patterned to match the defect and were laid in place without suturing. A pressure dressing was applied.

Reference to the operative reports (Table 1) will show that dermatome grafts either in the form of whole grafts or squares will take successfully in severely burned patients with marked anemia. (Figs. 2 and 3.)

### CONCLUSIONS

1. A case of a severely burned patient moribund from toxemia, anemia, and hypoproteinemia is described in which extensive free grafting was successful even though the hemoglobin was below 50 per cent and the plasma protein level at 5.

2. A quick efficient non-shocking method of resurfacing extensive flat raw surfaces is to employ thin split-thickness dermatome squares in a checker-board fashion.

3. Thin split-thickness dermatome squares will take in moribund patients with the hemoglobin as low as 30 per cent and the plasma protein level as low as 5 in the presence of infection.

4. Split-thickness dermatome squares are highly economical in that large areas may be covered with a minimum quantity of skin.

5. Split-thickness dermatome squares are superior to pinch grafts in that they may be cut more quickly, are of uniform thickness, and take better.

### REFERENCES

1. ACKMAN, D., GERRIE, J. W., PRITCHARD, J. E. and MILLS, E. S. A report on the management of burns. *Ann. Surg.*, 119: 161, 1944.
2. BERKOW, S. G. Method of estimating extensiveness of lesions (burns and scalds) based on surface area proportions. *Arch. Surg.*, 8: 138, 1924.
3. BROWN, J. B. and McDOWELL, F. Massive repairs of burns with thick split-skin grafts. *Ann. Surg.*, 115: 658, 1942.
4. BROWN, J. B. and McDOWELL, F. Plastic repair of burns with free skin grafts. *Clinics*, 1: 24, 1942.
5. BROWN, J. B. and McDOWELL, F. *Skin Grafting*. Philadelphia, 1943. J. B. Lippincott Co.
6. CONVERSE, J. M. and ROBB-SMITH, A. H. T. The healing of surface cutaneous wounds: its analogy with the healing of superficial burns. *Ann. Surg.*, 120: 873, 1944.
7. COPE, O., NATHANSON, I. T., ROURKE, G. M. and WILSON, H. Metabolic observations in burns. *Ann. Surg.*, 117: 937, 1943.
8. DAVIS, J. S. The small deep graft. *Ann. Surg.*, 89: 902, 1929.
9. DAVIS, J. S. Skin grafting at the Johns Hopkins Hospital. *Ann. Surg.*, 50: 542, 1909.
10. DAVIS, J. S. and TRAUT, H. F. Origin and development of the blood supply of whole thickness skin grafts. *Ann. Surg.*, 82: 871, 1925.
11. DAVIS, J. S. The late plastic care of burn scars and deformities. *J. A. M. A.*, 125: 621, 1944.
12. EVANS, E. I. and ALM, T. J. Plastic surgery of severe burns. *Virginia M. Monthly*, 71: 342, 1944.
13. FARMER, A. W. Experience with burns. *Am. J. Surg.*, 59: 195, 1943.
14. FICARRA, B. J. and NACLERIO, E. A. The physiological disturbance in a severe burn. *Surgery*, 16: 529, 1944.
15. GABARRO, P. A new method of grafting. *Brit. M. J.*, 1: 723, 1943.
16. GURD, F. B., ACKMAN, D. and SMITH, F. Planned Timing in the treatment of wounds and infections by means of infrequent occlusive dressings. *Ann. Surg.*, 118: 921, 1943.
17. GURD, F. B. and GERRIE, J. W. The early plastic care of deep burns. *J. A. M. A.*, 125: 616, 1944.
18. HARDY, S. B. and McNICHOL, J. W. The use of small pieces of film-covered skin grafts. *Surg. Clin. North America*, p. 281, April, 1944.
19. HARKINS, H. H. The local treatment of burns. *Clinics*, 1: 24, 1942.
20. HIRSCHFELD, J. W., WILLIAMS, H. H., ABBOTT, W. E., HELLER, C. G., and PILLING, M. A. Significance of the nitrogen loss in the exudate from surface burns. *Surgery*, 15: 766, 1944.
21. JENNEY, J. A. A modification of the plasma fixation method of skin grafting by the use of a bobbinet and a mirror attachment. *Am. J. Surg.*, 67: 3, 1945.
22. KANTHAK, F. F. Dermatome pattern graft and its use in reconstruction of the hands. *Surg., Gynec. & Obst.*, 77: 610, 1943.
23. LAM, C. R. The chemical pathology of burns. *Surg., Gynec. & Obst.*, 72: 390, 1941.
24. LANGE, K. The vascular prerequisites of successful skin grafting. *Surgery*, 15: 85, 1944.
25. LUCIDO, J. Metabolic and blood chemical changes in a severe burn. *Ann. Surg.*, 111: 640, 1940.
26. MARTIN, J. D., JR. Clinical and experimental studies of burns. *J. M. A. Georgia*, 27: 39, 1938.
27. MULHOLLAND, J. H., TUI, C., WRIGHT, A. M., VINCI, V. and SHAFIROFF, B. Protein metabolism and bed sores. *Ann. Surg.*, 118: 1015, 1943.
28. PADGETT, E. C. Calibrated intermediate skin grafts. *Surg., Gynec. & Obst.*, 69: 779, 1939.
29. POTH, E. J. Technique of skin grafting. *Surg., Gynec. & Obst.*, 75: 779, 1942.
30. ROBACK, R. A., and IVY, A. C. The therapy of burns. *Surg., Gynec. & Obst.*, 79: 469, 1944.
31. SALTONSTALL, H. and LEE, W. E. Modified technic in skin grafting of extensive deep burns. *Ann. Surg.*, 119: 690, 1944.

32. SCUDDER, J. and ELLIOTT, R. Controlled fluid therapy in burns. *South. Med. & Surg.*, 104: 651, 1942.
33. STRAATSMA, C. R. The role of free skin grafts in surface defects. *Surg. Clin. North America*, 309, April, 1944.
34. TAYLOR, F. H. L., LEVENSON, S. M., DAVIDSON, C. S., BROWDER, N. C. and LUND, C. C. Problems of protein nutrition in burned patients. *Ann. Surg.*, 118: 215, 1943.
35. TAYLOR, F. H. L., LEVENSON, S. M., DAVIDSON, C. S., ADAMS, M. A. and McDONALD, H. Abnormal nitrogen metabolism in burns. *Science*, 97: 423, 1943.
36. TIDRICK, R. T. and WARNER, E. D. Fibrin fixation of skin transplants. *Surgery*, 15: 90, 1944.
37. WEBSTER, J. B. Refrigerated skin grafts. *Ann. Surg.*, 120: 431, 1944.
38. YOUNG, F. Skin Graft fixation of plasma thrombin adhesion. *Ann. Surg.*, 120: 431, 1944.



PEDICLED skin grafts may be classified as simple, compound, and lined. A simple graft is composed of skin and subcutaneous tissue. A compound graft contains skin, subcutaneous tissue, and bone, cartilage, or muscle. A lined graft is a simple graft, the undersurface of which is covered with epithelium by folding the pedicle or by applying an Ollier-Thiersch graft.

From "Operations of General Surgery" by Thomas G. Orr (W. B. Saunders Company).

# TECHNIC OF CONTINUOUS PENTOTHAL ANESTHESIA

CAPTAIN N. B. KORNFIELD

MEDICAL CORPS, ARMY OF THE UNITED STATES

THE purpose of this paper is to present a method for the administration of intravenous anesthesia. The method was designed especially to accommodate an overwhelming flow of cases with a minimum of personnel and equipment, such as would be met in a combat zone. The technic embodies mechanical aids to allow the anesthetist greater freedom and ease in administration to a single patient, or the simultaneous administration to several patients if this is necessary. The method is not entirely new, and other methods may be found equally effective<sup>1,2,3</sup> but the equipment described here is made of such readily obtainable material that its war-time production is feasible, and its loss would not prove costly. Its compact form makes for ease of transportation, which should prove of greatest value to mobile surgical groups. The technic of administration requires a minimum of sterile equipment, allowing an uninterrupted flow of patients with practically no re-sterilization of material. The plethora of detail is meant as no insult to the intelligence of the experienced anesthetist, but merely as step-savers for the uninitiated. However, variation in equipment or technic may be made to suit the individual anesthetist.

## THE ARMBOARD

As illustrated in Figure 1, the armboard<sup>4</sup> is made of wood, is 36 in. long and 4 in. wide, and is hinged at its center so that it can be folded and thus more easily packed. It is tapered, to permit its easy insertion beneath mattress or blanket, beginning the taper well out on the bottom side, so that it will fold flat. It is varnished to facilitate cleaning. A small block, with pegs as illustrated, is used to hold the

syringe. There are several holes on each side of the board to enable the block to be placed in several positions as may be desired. When the board is folded, the pegs are placed in holes in the flat of the board as shown, again with the objective of compactness. The set for a mobile surgical team should include two boards so that two tables may be operated simultaneously.

To fasten the syringe to the v-shaped groove in the end of the block, a headless nail is driven through the block in about its center, notches are cut beneath the nail ends which are then bent down into the notches. Thus there are no protruding ends to catch the patient's arm. The syringe fastener consists of about 4 inches of narrow rubber tubing, (from the U.S. Army plasma set) into either end of which an "8"-shaped piece of wire is tied. The protruding loop is hooked over the bent nail on either side as illustrated. This single strand of rubber tubing will be found quite sufficient to hold the syringe firmly in place.

A narrow canvas strap (1 inch wide) with a simple buckle, will be found convenient to hold the patient's arm in place on the board. It is best to run the strap over the palm of the hand, for here it may be tied snugly without impeding the circulation, and it will also prevent the patient from bending his wrist and striking the syringe with his fingers. It may be tacked, near the buckle, to the bottom of the board an inch or two from the end.

An objection that has been made is that any armboard would be inconvenient if not impossible to use when an army stretcher is used as an operating table. The objection is based upon the fact that the concavity of the canvas would either



make the board extend at too steep an angle, or prove uncomfortable beneath the back of the patient. By placing one

been a standard B-D with the following alteration: The standard stopcock has one male and one female Luer-lok connection,

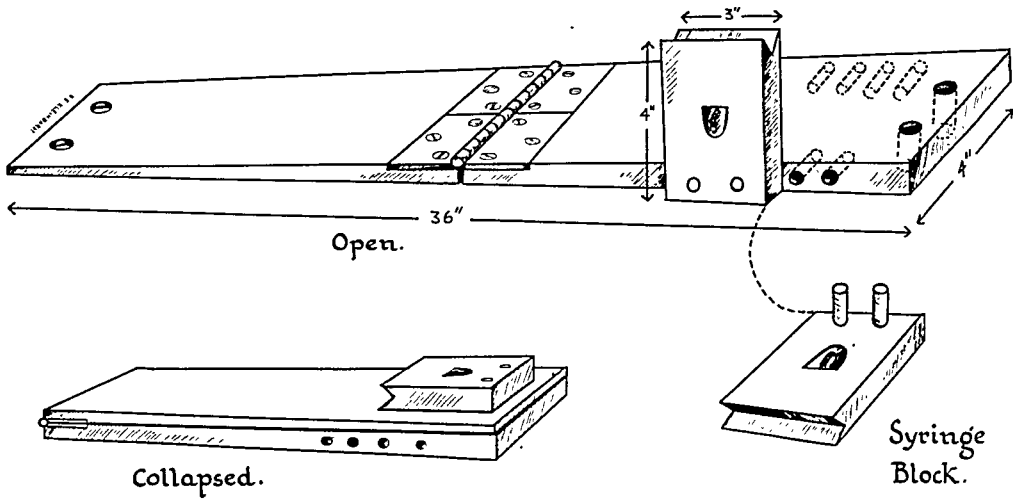


FIG. 1. Intravenous anesthesia arm board.

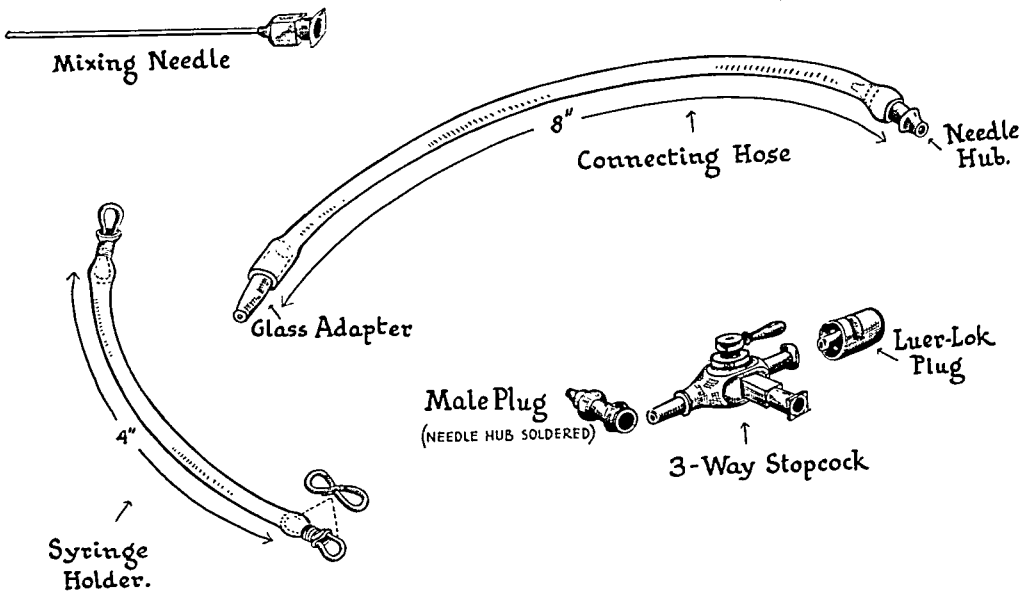


FIG. 2. Intravenous anesthesia equipment.

or two folded blankets or a pillow beneath the shoulders and head of the patient, and inserting the armboard between them, this objection is overcome. On an ordinary operating table it is inserted with great ease between mattress and table.

#### THE INTRAVENOUS EQUIPMENT

A three-way stopcock is essential for the most efficient use of this technic. The best stopcock encountered (Fig. 2) has

and one ribbed projection to take a rubber hose. This ribbed projection is removed and a female Luer-lok connection welded in its place. It will thus take the adapter of an infusion or plasma set, or a Luer-lok plug (Fig. 2) to close this opening for short administrations where an infusion is not desired. Thus, in effect, the stopcock is either a two- or three-way stopcock. But any three-way stopcock with Luer fittings can be used. Two stopcocks should

be included in a set, but a third may be necessary because a stopcock may go out of order.

The syringe used is the standard army 30 cc. one, and three syringes are all that are necessary to run two tables, although several others should be included in the set to provide for breakage. Two mixing needles, made by filing the bevels off of long No. 15 gauge needles, will be found valuable.

The connecting hoses (Fig. 2) are made from the narrow bore, transparent rubber tubing found in the plasma sets. The female connection at one end is made from a needle hub, a rounded hub being most satisfactory, and the glass adapter from the plasma set is used at the other. The length of the hose is about 8 inches, although several hoses of extra length should be included for cases in which the patient is on his face or in some other awkward position. At least a dozen of these hoses should be included, although more may be found convenient, for it is about this point that the efficiency of the technic pivots. The rubber should be replaced periodically.

A saline infusion, although plasma or blood can be substituted, is set up at each table. A plug (Fig. 2) made by soldering the opening of a needle hub, as described by Lundy,<sup>5</sup> may be used to close the male nipple of the stopcock between cases and also protect it from contamination. This plug will be found very useful to close and protect syringes and infusion adapters in all stages of operation, and several extra plugs should be included in each set. Instead of the breakable glass adapter, the metal adapter from a broken syringe is advantageously tied into the infusion hose.

#### TRAY SET-UP

The tray, stand, table, or end of a packing case, which is used as a work bench need not be sterile. As illustrated in Figure 4, the only sterile part is the folded towel, placed in a small pan for convenience, in which is kept the stock of sterile

connecting hoses and needles. A small dish filled with alcohol is used to contain plugs and stopcocks. A sterile hemostat is placed with its end in the alcohol and used to remove connecting hoses, etc. The remainder of the working surface does not need to be sterile, for the syringes are protected by plugs and the sponges and ampules are surgically clean. It will be convenient to keep the ampules in a stand if this is available. A waste container is not essential. This set-up is placed convenient to the operating table, or between the two tables if such is the case, and if the working surface is large enough, may be used to hold the armboard between cases.

#### TECHNIC OF ADMINISTRATION

The syringes, needles, stopcocks, plugs and connecting hoses are sterilized by any suitable means. Autoclaving is best, and should be done before becoming active, but boiling, or even submersion in 95 per cent alcohol will suffice if necessary. The lot is placed in the sterile folded towel which is placed in the pan. This then becomes the reservoir from which the items are drawn as required. A fresh supply of connecting hoses and needles is sterilized for each twenty-four hours' work, but the plugs and stopcocks may be left in the alcohol.

At the onset of an operative list each of the three syringes is filled with a 2½ per cent solution of pentothal. It should be noted here that if the mixing needles are left standing in the empty ampules, they will remain sterile for their next use. A central reservoir of pentothal may or may not be used. The stopcocks, with plugs in place, are connected to two syringes and the third is kept in reserve, plugged and thus left with safety on the "contaminated" part of the tray.

This method does not contemplate the use of an anesthetic room. Induction can be easily accomplished in the operating room after the patient has cooperated in adjusting himself to the best position on

the table. The patient will be ready for the "prep" in one minute, no time is lost, and the fear that he will suffer psychologi-

cock and the adapter of the infusion set put in its place. The other plug is replaced by a connecting hose and needle. Both

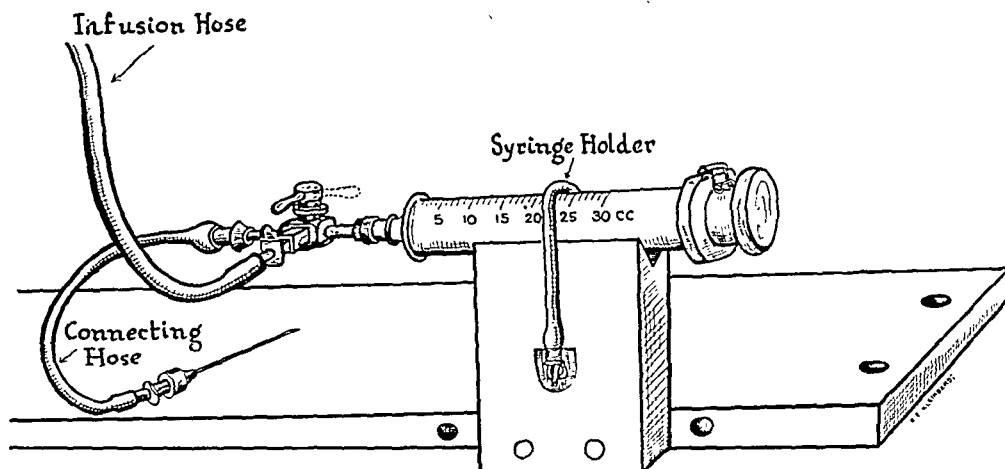


FIG. 3. Intravenous anesthesia equipment assembled.

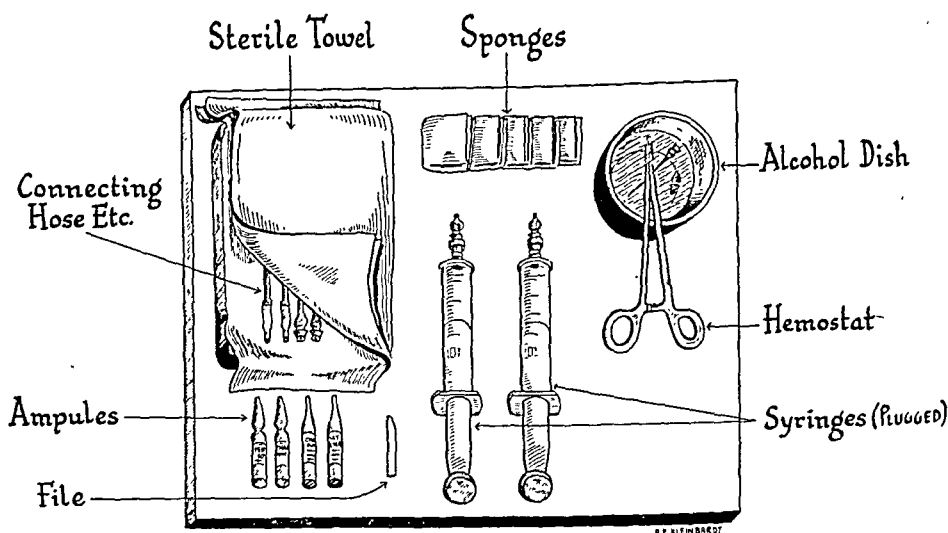


FIG. 4. Tray set-up.

cal shock on entering the operating room awake, is found on actual practice to be practically non-existent. Of course, in the tent operating room, as many as six tables may be in operation at once and there is no possibility of an anesthetic room.

When the patients come in, an armboard is adjusted for each, padded with a towel, and the arm is gently tied in place with the strap. The syringe and stopcock are then fastened firmly on the block. The Luer-lok plug is removed from the stop-

plugs are then placed in the dish of alcohol. The connecting hose is filled with the saline from the infusion. The purpose of the saline infusion is to keep the needle open. The stopcock is turned to a half-way position to shut off both infusion and syringe, and all is ready.

The needle is first inserted in the vein and taped securely in place. The infusion is now allowed to run by turning the stopcock to the proper position. A rate as slow as 40 drops per minute is more than sufficient to keep the needle open. To start the

anesthetic, the stopcock is switched to the syringe, automatically stopping the infusion, and pentothal is injected. When the patient is in the desired plane, the stopcock is switched back to the infusion. In estimating dosage, remember that the connecting hose contains about 2 cc. of pentothal which will be carried into the circulation when the infusion is again allowed to run. The anesthetist is now free to adjust the air-way, administer oxygen or nitrous oxide, or attend to any other tasks required of him. He needs no assistant. From time to time he may inject more pentothal as required. As one syringe is emptied, it is disconnected from the stopcock and a full syringe substituted, the emptied syringe being refilled and plugged.

Upon the conclusion of the anesthetic, the infusion is stopped by switching the stopcock, to half-way position, and the needle is withdrawn from the vein. The used connecting hose is removed from the stopcock, whose nipple is protected and plugged by a sterile plug taken from the alcohol. The armboard is now gently withdrawn from beneath the patient, the syringe, etc., remaining in place, and then readjusted beneath the arm of the next patient when he is brought in. A fresh, sterile connecting hose and needle is attached, and all is ready for the next administration. This is possible without any break in sterility since the patient's blood has never flowed further back than the connecting hose.

Thus the only piece of equipment to be resterilized between cases is the connecting hose and needle. If enough of these are on hand there will be enough for a complete series of cases without any resterilization whatsoever. The syringes do not come into contact with the patient, and are merely used in rotation to mix pentothal solution. Pentothal left over from one case may be used for the next. The same infusion may be used for successive patients since that part of the apparatus is not contaminated either. The adapter of the infusion hose is plugged between patients. If blood or

plasma is necessary in the course of any anesthetic, the saline is discontinued while the blood or plasma is running. The saline should be used to wash out the stopcock before the next administration.

This method has been used by the author in both American and British hospitals in England during the year before invasion. At this writing it has had vast use on battle casualties in France, Belgium and Germany. It has been the method employed in about 80 per cent of all anesthetics administered. It has been used by the author and a number of his fellow anesthetists, in an amphibious clearing station, evacuation, general and field hospitals. It has proved quite satisfactory from the point of convenience, safety, and economy of time and material. No untoward complications have arisen. It enables the anesthetist to administer two anesthetics simultaneously; and, since the majority of cases are relatively superficial debridements, it saves much valuable time.

#### SUMMARY

A method for the administration of intravenous anesthesia is presented. It has proved especially useful in the field since the equipment is compact and easily obtained, but it has been found to be effective in any operating room. A minimum of sterilization is necessary. The anesthetist can easily administer successive and simultaneous anesthetics, and be free to administer oxygen or oxygen and nitrous oxide or give plasma and blood if necessary.

#### REFERENCES

1. FRENCH, E. A. Pentothal sodium oxygen anesthesia in major surgery. *Am. J. Surg.*, 61: 16-37, 1943.
2. HOLLY, J. D. Pentothal sodium in major surgical procedures. *Am. J. Surg.*, 62: 13-18, 1943.
3. RAFFAN, A. W. Continuous intravenous anesthesia with sodium pentothal at a military hospital in the Middle East. *J. Roy. Army Med. Corps.*, pp. 257-261, May, 1943.
4. KORNFIELD, N. B. A simple but effective armboard. *Med. Bull. No. 4, Office of the Chief Surgeon, European Theater of Operations*, pp. 9-14, May 15, 1943.
5. LUNDY, J. S. *Clinical Anesthesia*. P. 268, Philadelphia, 1942. W. B. Saunders Co.

# INGUINAL HERNIORRHAPHY

THEODORE L. HYDE, M.D.

Chief of Surgical Section, The Dalles Clinic

THE DALLES, OREGON

INGUINAL herniorrhaphy is one of the most common operations but it is not one of the most successful.<sup>1</sup> It may well be called one of the unsolved problems of surgery because there is a distressingly high percentage of recurrences.<sup>2</sup> Since the technical performance of the operation is not thought to be difficult and the risk is low, many doctors attempt this unsolved problem who hesitate to assume the responsibility of operations like thyroidectomy. Theoretically, inguinal herniorrhaphy should be 100 per cent successful when done as an elective operation.<sup>3</sup> Even relatively unavoidable surgical hazards such as wound infection and pneumonia are not conspicuous causes of failure.<sup>4</sup> We believe recurrence is usually the result of a fundamentally defective operation. The cure of inguinal hernia is essentially a problem in plastic surgery and the principles of plastic surgery apply.<sup>5</sup> Among these are (1) the use of grafts, (2) the use of non-absorbable cotton suture material,<sup>33</sup> (3) avoidance of tension on the sutures, and (4) providing adequate rest time for healing. In recent years considerable progress has been made along these lines and the operation as now performed is significantly different from that done five years ago.<sup>6</sup> Although there have been no recurrences on an active surgical service of over 500 herniorrhaphies in the past year, our follow-up is admittedly inadequate. Furthermore most of the operations have been on active healthy young men who are not fair test material for any method of herniorrhaphy.\* Accordingly we do not present statistical proof of the methods advocated. Rather the operation is based logically upon principles estab-

lished in other fields of surgery, anatomy, and physiology.<sup>7,8</sup>

Ordinarily the mere existence of an inguinal hernia is the necessary indication for herniorrhaphy. Occasionally a patient will present a small, visibly bulging direct hernia which is asymptomatic and which may have been present for years. Apparently it is possible for such hernias to remain non-progressive for many years if the external oblique fascia is strongly supportive and herniorrhaphy is unnecessary. The mere presence of an enlarged external inguinal ring does not establish the diagnosis of hernia, nor in fact does an enlarged ring even predispose to the subsequent development of a hernia. Some indirect hernias are inconstant and remain reduced for days at a time. The history of bulging is unreliable and operation should be delayed until the surgeon himself can observe the hernia. The diagnosis of small incomplete hernia is sometimes made possible by palpating a characteristic thrill over the inguinal canal after a cough. The omentum enters the hernia sac during the cough and can be felt to slip back into the abdomen if pressure is applied by the hand directly over the canal immediately after a cough. Particular contraindications to elective herniorrhaphy are a chronic cough and skin irritation in the inguinal region. Some smokers have to reduce their smoking for a month and occasionally an irritating truss has to be discarded for a while preoperatively.

Spinal anesthesia with its complete relaxation is so desirable as practically to leave no second choice. Procaine in high concentration to obtain paralysis will usually be satisfactory although we commonly use the longer lasting metycaine and occasionally pontocaine for bilateral

\* This article was written while the author was Chief of General Surgery of a large Army Hospital.

operations. The freedom from postoperative vomiting is an additional virtue of spinal anesthesia as some herniorrhaphies are broken down immediately postoperatively by the violent retching of a semi-conscious patient.

Bilateral herniorrhaphy is permissible unless the first and worst side takes over an hour. We no longer feel justified in exploring the other side routinely, although a plastic operation on one side does not affect the other inguinal region.<sup>9</sup> The morbidity of the bilateral operation is increased but not doubled. Bilateral hernias often are larger and more difficult to repair, but otherwise there is no reason for expecting a bilateral repair to be less successful than two repairs at separate operations. If the appendix can be completely and easily delivered into the wound, the appendix is removed but usually it is merely explored with the finger.

The skin incision is located by placing the finger in the subcutaneous inguinal external ring. It is made parallel to the inguinal ligament directly over the spermatic cord and extended far enough medially to expose the external ring completely. The several subcutaneous blood vessels can often be caught in small pointed clamps before cutting. These are tied with No. 80 plain cotton white thread taking care to include only the vessel and to avoid creating tufts of strangulated fat.<sup>10</sup> The incision with the knife is carried down through the external oblique aponeurotic fascia at the middle of the external ring. The fascial fibers are separated laterally to expose the cord. The use of scissors to separate these fibers is unduly hazardous to the ilio-inguinal nerve and its branches. These nerves are inconstant and often very bothersome but are respectfully preserved. They are very susceptible to stretching by rough retraction. The two edges of the incision in the external ring are caught by two Carmalt clamps for retraction and as markers. The Carmalt clamp is the least traumatic type

of clamp available but should not be too tightly closed.

The cord is then elevated by scissor dissection down toward the spine of the pubis.<sup>11</sup> If this dissection is done rapidly and accurately, one has the advantage of a clear field unstained by blood. There is usually one branch of the inferior epigastric artery on the posterior surface of the cord which requires tying. A broad thin rubber drainage tube is slipped under the cord for retraction. Bundles of the cremaster muscle often arch down from the cord medially to the internal oblique muscle. These bundles are cut close to the internal oblique muscle allowing the loose ends to fall back along the cord and the cord is elevated all the way up to the abdominal, inguinal internal ring.

The cremaster muscle is then incised longitudinally with the knife for about  $1\frac{1}{2}$  inches just below the superior border of the internal ring on the anteromedial aspect of the cord. With the cord elevated and held on one finger it is explored through this incision. Exploration lower than this will sometimes fail to reveal a short sac. The congenital sac of indirect hernia is always immediately adherent to the ductus deferens as it leaves the abdomen. If no sac is found, the peritoneum is opened at this site anyway.

The inguinal region of the abdomen is then explored. Unsuspected femoral hernias are occasionally found. Most important, however, is the estimate of the direct hernia defect. The essential characteristics of direct and indirect hernias should be kept clearly in mind. The inferior epigastric artery is often taken as the distinguishing landmark but really whether the bulge is above or below this artery is incidental. An oblique indirect hernia follows a congenital preformed sac of incompletely obliterated vaginal process of the descending testis. A direct hernia bulges through a weak area bounded above by the upper border of the internal ring and laterally by the inguinal ligament. The medial edge of this defect is formed by the arching

fibers of the internal oblique and transversalis muscles and fascias. These arching fibers sometimes close snugly under the

preformed sac are both parts of a single developmental defect, but regardless of their origin the observed fact is that they

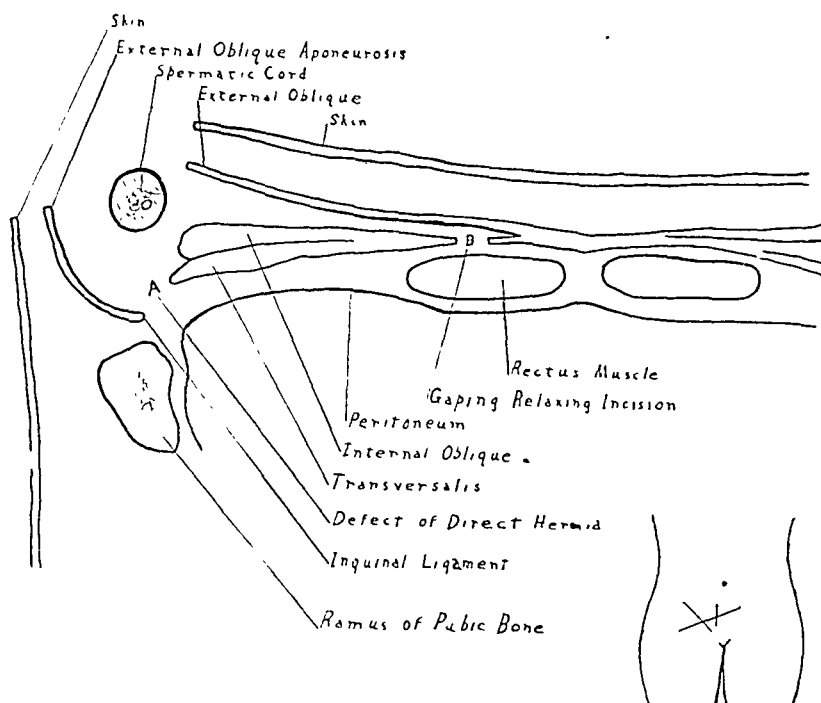


FIG. 1. Diagram of cross-section through the direct hernia defect (A) and the relaxing incision in the anterior rectus sheath (B). The tissue between A and B constitutes a sliding graft to close the defect A. The insert shows the line of the inguinal incision, the site of the relaxing incision, and the plane of the cross-section.

cord over to the inguinal ligament forming a tight circular internal ring, but commonly they arch down lower, even to the spine of the pubis forming an oval and defective internal ring. This medial edge is very easily identified by the exploring finger within the abdomen but almost impossible properly to appreciate from the outside. Every indirect hernia, therefore, has a direct hernia component. An indirect hernia emerges along the prepared avenue of the congenital sac which serves as an entering and dilating wedge but the defect in the abdominal wall is the same as that for a direct inguinal hernia. Sometimes this defect is merely an enlarged internal ring stretched by the radial expansion of the mass of the indirect hernia but usually it is a definite weakness of the region below and medial to the internal ring. Perhaps this direct weakness and the

co-exist and deserve separate consideration in the operative repair of every inguinal hernia.<sup>12</sup>

The sac is then stripped. If it extends down around the testicle, the sac is excised at the reflexion of the visceral tunica vaginalis. This dissection follows the sac closely and is facilitated by dissecting against the tip of an inserted index finger. The loose alveolar tissue is wiped off the sac with gauze while the assistant snips judiciously with scissors at adherent points. Clamps on the sac for traction usually pull off but control of the sac is easily maintained by holding it under some gauze between the thumb and the base of the index finger. Any bleeding veins are carefully tied because hematomas readily form in the loose tissue of the cord. The entire dissection of the sac is carried out through the short incision in the cremaster.

If the testicle has had to be pulled up into view, it is accurately replaced by grasping its lower pole with a long curved Carmalt clamp and poking it down into place. The testicle is carefully observed as it is pulled out of the scrotum to avoid confusion in its reposition. The testicle may be erroneously replaced with torsion, subcutaneously into the scrotum, or back into the perineum unless due care is taken.

If no indirect sac is found, the direct sac is pulled up through the same incision in the cremaster and stripped.<sup>13</sup> Even when an indirect sac is present there is usually also some redundancy of the peritoneum down toward the bladder ("pantaloonsac"). This redundancy is pulled up along with the indirect sac and the preperitoneal fat dissected off. The bladder is often pulled into view. The inferior epigastric artery is sacrificed if necessary. The direct sac is merely a secondary result of the direct hernia bulging through the defect in the abdominal wall and is not a significant etiological factor like the congenital sac is in indirect hernias.

If the omentum has been in the sac, it is gently pulled out of the abdomen as far as it easily can be and amputated. It is doubly clamped and cut in eight or ten pedicles, which are tied with No. 60 cotton thread leaving minimal tufts to form adhesions. We believe that the omentum is a contributory cause of hernia. Many patients with a complete congenital sac never develop the hernia even through the strenuous period of childhood until in the third decade when the omentum has grown long enough to act as an entering wedge. Patients with bilateral congenital sacs sometimes do not develop the second hernia as long as the omentum is held on the first side. The omentum is much more fluid than the bowel and more easily enters any hernial defect and especially an indirect congenital sac. After amputation it may hypertrophy again. We believe its importance as an organ of defense against infection has been exaggerated and have never regretted removing it.<sup>14</sup> No

doubt many other surgeons have removed the omentum similarly during herniorrhaphy especially when it was adherent in the sac but we have not been able to find elsewhere in the literature such a discussion of its etiological rôle nor anyone advocating its routine amputation as we do. Appendectomy is also done at this time if it is indicated.

Before the sac is closed the stitches to close the direct hernia defect are placed with the index finger in the abdomen as a guide. If there is much redundancy of the preperitoneal fat and fascia, it is gathered in a row of six interrupted stitches of No. 40 cotton. These stitches need not include the inguinal ligament nor attempt to obtain firm fascia medially. This first row of gathering stitches is placed and tied. Then a second row of stitches is placed beginning at the pubic spine to approximate the inguinal ligament and the medial edge of the defect. If the inguinal ligament is attenuated or if there is any suggestion of a femoral hernia Cooper's ligament is used as the lateral anchor for the lower part.<sup>15</sup> Cooper's ligament is in some respects a more physiologic lateral edge for this deeper suture line than the inguinal ligament. It is serviceable only as far laterally as the femoral vein which must be clearly exposed to avoid accidental puncture. The medial edge must be accurately identified, too. Sometimes the muscle fibers of the internal oblique extend nearly to the spine of the pubis and obscure it. These muscle bundles must be retracted medially or separated bluntly and no more than necessary to expose the white transversalis fascia below. Any red muscle included in this stitch will cut through and the area will be weakened. The glib textbook phrase "sew the conjoined tendon to Poupart's ligament" sounds deceptively simple. "Conjoined tendon" is a very inaccurate description of the tissue usually found at the medial edge of the direct hernia defect. A big stitch through the inguinal ligament and then through a big bite of tissue in the conjoined tendon area



pulls those structures together but does not hold them together for long because the stitch cuts through the red muscle part of the "conjoined tendon." We believe this to be the commonest technical error of herniorrhaphy and the largest single reason for failure. It is worse than useless to attempt to sew red muscle to white fascia because the muscle will cut through and the area will be weakened instead of strengthened. The stitches should be made with No. 40 plain white cotton and are placed every 8 to 10 mm. up to the internal ring. Unless the cord is very small it is separated into two bundles by blunt dissection and two of the stitches are taken through it creating in effect two internal rings (Torek).<sup>16</sup> No stitch is taken above the ring as the natural upper edge of the ring usually is very satisfactory firm tissue and cannot be improved upon.<sup>17</sup> Its muscular sphincter action should not be impaired. These stitches are taken with 15-inch strands of thread, clamps are placed on the ends and they are not tied until the sac is closed.

When the guiding finger inside the abdomen is no longer necessary the sac is closed. The peritoneum of the sac is pulled up firmly and an internal purse-string suture of No. 30 cotton is placed in the peritoneum at the level of the internal ring. When this is tied the peritoneum is closed smoothly. A second reinforcing transfixing ligature is applied to the stump of the sac and the excess amputated. This closure then retracts naturally up under the superior border of the internal ring. Efforts to fix it up there with a stitch through the muscle are unnecessary and usually involve undue tension. The previously placed stitches in the direct hernia defect are then tied. The clamps on the stitch threads are pulled up firmly by the assistant closing the suture line while the stitches are tied successively from below upward and thus each stitch is tied without tension during the knotting.

A narrow strip of the fascia of the medial edge of the incision in the external oblique

is then split off leaving the upper end attached. The lower end is threaded into a Gallie needle and is sutured in place as a graft to reinforce the internal ring (MacArthur).<sup>18</sup> The needle enters the internal oblique muscle at the medial border of the internal ring, pierces the cord through the above mentioned separation, catches the inguinal ligament, crosses back below the cord to another bite in the medial edge, pierces the fascia strip itself as it again goes through the cord, again catches the inguinal ligament, and then is threaded up through the internal oblique muscle above the ring to be sutured to itself with a cotton stitch. If this figure-of-eight graft is not pulled too tightly, it will not cut through the muscle but survives as strong tissue.<sup>19</sup> Sometimes the natural hood-like effect of the internal oblique muscle over the internal ring may be accentuated by a stitch from the superficial fascia on the anterior surface of the internal oblique muscle over to the inguinal ligament. The incision in the cremaster muscle is then closed with four stitches. Careful gentle dissection and suturing will have preserved the integrity of the cremaster muscle and the cord even with dissection of a sac down around the testicle.

This type of operation will cure most small hernias. The high suture closure and amputation of the sac cures indirect hernias and recurrence of indirect hernia is only possible if the sac is not tied high enough or missed entirely. Aside from these gross errors any recurrence must be a direct hernia by definition and the distinction is important. Conceivably a direct hernia could exit through the internal ring and dissect itself down along the cord, but it would still be essentially a direct hernia when considered as a surgical problem. In fact, as should be apparent from the above discussion, we consider all inguinal hernias to be essentially direct hernias when considered as a surgical problem. The exception to this is the repair of congenital inguinal hernias of infants. Simple removal of the sac seems to cure these and since the

cord in infants is so easily injured such extensive dissection and suturing as we have described is not necessary or desirable.

Fascia lata suture-graft from the thigh is indicated to close the direct hernia defect if the hernia is a recurrence, if the defect is large, if the patient is obese, if the tissues seem weak, if the exploring finger cannot definitely outline the medial edge of the defect, or if the patient has a chronic cough.<sup>20, 21, 22</sup> This entails slight additional risk although we have never had a complication arise in the thigh wound.<sup>23</sup> Cutis graft may be used instead of fascia lata.<sup>24</sup> Every patient is draped so that fascia lata can be used whether the original plan of operation included it or not. We use a Masson fascia stripper through a small incision below and anterior to the greater trochanter.<sup>25</sup> Wounds heal from the sides and not the ends so a long incision in the thigh to obtain the fascia is perfectly permissible if no fascia stripper is available.<sup>26</sup> A strip  $\frac{3}{4}$  by 12 inches is easily obtained and splits into three adequate sutures. The tear in the fascia lata need not be closed.<sup>27</sup> The fascia lata sutures are used instead of the above described row of sutures approximating the two edges of the direct hernia defect and the strip of fascia from the external oblique. The fascia is really not as much a suture to approximate the two edges as it is a graft bridging across the defect with a lattice-work crosshatching.<sup>28</sup> The fascial suture is prepared by firmly tying each end with a cotton suture. Then a small Gallie needle is threaded on the upper end, backed on about an inch, the point of the needle is pierced through the fascial suture just proximal to the terminal tie and pulled on through. The first stitch is taken and caught as a loop by sewing the needle through the strand just proximal to the tie in the other end. Subsequent weaving of the stitches is accomplished by frequently sewing the suture through itself. The fascial suture is carried up around the upper border of the internal ring and the cord may be carefully pierced in two or

three places. The needle should bite deeply into the medial edge and it is unnecessary to avoid including red muscle in the stitch since it is not pulled too tightly and does not cut through. The lower part of this graft can be placed with the finger inside the abdomen but before it is completed the sac must be closed as described above.

When the direct hernia defect has been closed, the result is palpated and the amount of tension is evaluated. In most cases a relaxing incision is desirable to create a sliding graft of the conjoined tendon area.<sup>29</sup> This is a three inch sagittal incision in that part of the anterior rectus sheath formed by the internal oblique aponeurosis. (Fig. 1.) It is made with the scissors from the pubic bone upward just lateral to the fusion of the internal and external oblique aponeuroses. The external oblique fascia is retracted strongly upward by the assistant and the two aponeuroses separated as far medially as possible. There is usually one small branch of the inferior epigastric artery which has to be tied. The lateral edge of this incision retracts laterally and any tension on the suture line relaxes. The lateral edge is usually left loose but it can be caught with four or five stitches to the overlying fascia of the external oblique. If this incision is made earlier in the operation, it is more difficult to identify the medial edge of the hernia defect. Halsted suggested folding the lateral edge of this relaxing incision over to the inguinal ligament.<sup>30, 31</sup> It seems more rational to use the tissue as a sliding graft than as a reflected graft. The defect created by this incision is amply covered by the rectus muscle posteriorly and the fascia of the external oblique anteriorly.

The external oblique fascia is then closed. It is usually desirable to narrow the external ring. Remembering the size of the original external ring marked by the two Carmalt clamps makes it easy to judge where to place the first and lowest stitch. The medial edge of the fascial incision is then snugly overlapped on top of the lateral sheet with mattress sutures

of No. 40 cotton along both edges. All sutures are placed before tying. The assistant again holds the wound closed by pulling up on the untied stitches while they are tied successively from below upward by the surgeon.

Various methods have been proposed of doubly transplanting the cord and moving the external ring laterally. The most reasonable is that of Willys Andrews who advocated sewing the lateral edge of the external oblique fascia under the cord to the anterior surface of the internal oblique fascia and then pulling the medial edge of the external oblique fascia over the cord and suturing it to the anterior surface of the lateral fascial sheet of the external oblique near the inguinal ligament.<sup>32</sup> We rarely find an external oblique fascia lax enough to treat this way. The strength of the external fascia can be used but once and whether placed above or below the cord does not seem important except for the distinct advantage of preserving the obliquity of the canal.

The subcutaneous fascia in this region is usually a distinct layer and is closed with ten or twelve interrupted No. 60 cotton sutures. The skin is closed with a running continuous cotton stitch. Interrupted skin stitches seem to be unnecessarily meticulous. After the dressing is applied the cremaster muscle is splinted with an adhesive plaster "Bellvue Bridge" across the thighs to support the scrotum.

Bed rest of fourteen to twenty-one days is enforced. Turning the patient on the side and leg bending exercises provide the activity necessary to avoid pulmonary and phlebothrombotic complications. Early ambulation is not justified in plastic herniorrhaphy. Sedatives are used freely throughout the bed rest period to obtain rest and cooperation.

#### CONCLUSIONS

1. Inguinal hernia is one of the unsolved problems of surgery.

2. Failures can be avoided by improving the technical performance of the operation.

3. Sutures without tension, the use of fascial and sliding grafts, and adequate healing-time are principles of plastic surgery particularly applicable to herniorrhaphy.

4. The omentum is a contributory cause of some hernias and should be amputated.

5. Plain white cotton thread is the suture material of choice.

#### REFERENCES

1. FERGUSON, A. H. The Technic of Modern Operations for Hernia. Chicago, 1907. Cleveland Press.
2. JOYCE, T. M. Fascial repair of inguinal hernia. *J. A. M. A.*, 115: 971, 1940.
3. ANDREWS, E. History of the development of the technique of herniotomy. *Ann. M. Hist.*, 7: 451-466, 1935.
4. LAVENDER, H. Factors influencing repair of inguinal hernia. *Surgery*, 13: 535-547, 1943.
5. STEIN, J. J. and BROWN, P. F. Repair of inguinal hernia. *Surg., Gynec. & Obst.*, 70: 1054-1057, 1940.
6. ZIMMERMAN, L. M. Essential problems in treatments of inguinal hernia. *Surg., Gynec. & Obst.*, 71: 654, 1940.
7. RAMOS, R. L. and BURTON, C. C. Results of treatment of inguinal hernia. *Surg., Gynec. & Obst.*, 70: 953-957, 1940.
8. FALLIS, L. S. Inguinal hernia. *Ann. Surg.*, 104: 403-418, 1936; 107: 572-580, 1938.
9. HICKS, E. S. Inguinal hernia. *Canad. M. A. J.*, 45: 134-136, 1941.
10. MEADE, W. H. and OCHSNER, ALTON. Relative value of catgut, silk, linen and cotton as suture material. *Surgery*, 7: 485, 1940.
11. BASSINI, EDUARDO. On the treatment of inguinal hernia. *Arch. klin. Chir.*, 40: 429, 1890.
12. McVAY, C. B. and ANSON, B. J. Anatomy of the inguinal region. *Anat. Rec.*, 70: 211-225, 1938; 76: 213-231, 1940.
13. HOGUET, J. P. Direct inguinal hernia. *Ann. Surg.*, 72: 671-674, 1920.
14. ROTHENBERG, R. E. and ROSENBLATT, P. Omental response. *Am. J. Surg.*, 62: 211-215, 1943; Motility of greater omentum, *Arch. Surg.*, 44: 764-771, 1942.
15. SEELIG, M. G. and CHOUKE, K. S. Fundamental factors in recurrence of inguinal hernia. *Arch. Surg.*, 7: 553-572, 1923; SEELIG, M. G., Fundamental principles underlying operative cure of hernia, *J. A. M. A.*, 88: 529-532, 1927.
16. SHELLEY, H. J. Reduction of recurrence after herniorrhaphy. *Texas State J. M.*, 37: 661-664, 1942.
17. SCHUTZ, C. B. Inguinal hernia. *J. Missouri M. A.*, 38: 231-233, 1941.
18. McARTHUR, L. Autoplastic suture in hernia. *J. A. M. A.*, 37: 1162-1165, 1901; 43: 1039-1048, 1904.
19. GRATZ, C. M., Strength of fascia lata. *J. Bone & Joint Surg.*, 13: 334-349, 1931.

20. GALLIE, W. E. and LEMESURIER, A. B. The use of living suture. *Canad. M. A. J.*, 11: 505-513, 1921; *Arch. Surg.*, 9: 516-529, 1924.
21. MORSE, L. J. and BARB, J. S. Free transplant of fascia lata. *Surgery*, 13: 524-534, 1943.
22. SMITH, C. H. and MASSON, J. C. Results of repair of hernia with fascia lata. *Surgery*, 7: 204, 1940.
23. BURDICK, C. G., GILLESPIE, D. and HIGINBOTHAM, N. Fascial suture operations for hernia. *Ann. Surg.*, 106: 333, 1937.
24. CANNADAY, J. E. Use of cutis graft. *Am. J. Surg.*, 59: 409-419, 1943.
25. GUTHRIE, R. F., OLSON, J. D. and MASSON, J. C. Results of herniorrhaphy with fascial and non-fascial sutures. *Surg. Clin. North America*, 23: 1177, 1943.
26. IASON, I. H. Fascia lata transplant for difficult hernias. *Surgery*, 13: 511-523, 1943.
27. FOSHEE, J. C. Fascia lata regeneration. *Surgery*, 14: 551-569, 1943.
28. GALLIE, W. E. Further experiences with the transplantation of fascia. *Tr. West. Surg. Ass.*, 49: 1936.
29. REINHOF, W. F. The use of rectus fascia in the repair of inguinal hernia. *Surgery*, 8: 326-339, 1940.
30. HALSTED, W. S. Radical cure of inguinal hernia. *Johns Hopkins Hosp. Bull.*, 1: 12-13, 1889.
31. BLOODGOOD, J. C. Transplantation of the rectus muscle sheath for inguinal hernia. *Ann. Surg.*, 70: 81-88, 1919.
32. ANDREWS, E. W. Imbrication: a plastic operation for hernia. *Chicago Med. Rec.*, 8: 57, 1895.
33. HYDE, T. L. Cotton surgical suture material. *Surgery*, 16: 407-415, 1944.



DIRECT inguinal hernias are more difficult to retain by a truss or to cure by operation, from the lack of obliquity of the canal, the large size of the orifice and the thinness of the abdominal wall at Hesselbach's triangle.

From "Principles and Practice of Surgery" by W. Wayne Babcock (Lea & Febiger).

# TREATMENT OF PULMONARY EMBOLISM\*

MAJOR LEWIS S. PILCHER

MEDICAL CORPS, ARMY OF THE UNITED STATES

PULMONARY embolism has always been one of the most tragic and most unpredictable of postoperative complications. In a recent comprehensive report from the Mayo Clinic<sup>1</sup> covering over 170,000 patients, pulmonary emboli occurred in one out of every 250 surgical cases. In this group the extreme severity of this complication was emphasized by the fact that of the 897 patients who had pulmonary emboli, 343 died. As usual, many of these patients were healthy individuals, considered good risks, who had had elective surgery and in whom such a complication was entirely unforeseen.

In spite of the seriousness of postoperative pulmonary embolus, there has not been a clear understanding of its exact etiology until quite recently. Of course, it has long been recognized that the emboli originate from venous thrombi which break off into the larger vessels and are carried to the lungs through the heart, but there has been considerable confusion as to the exact mechanism and site of the original thrombus formation. It has gradually been established that there are two stages: First, the thrombosis of a peripheral vein, often but not always associated with a variable degree of thrombophlebitis. This thrombosis then extends proximally until it reaches the junction with a larger vein. At this point the second stage starts, namely, the formation proximally in the larger vein of a free propagating thrombus, with its base fixed to the thrombosis in the small vein and its tip floating free in the lumen of the larger vein. It is this propagating thrombus and not the original peripheral thrombus which breaks off and forms the pulmonary embolus. The original thrombus, especially

if there is any thrombophlebitis present, is usually firmly fixed to the vein wall and cannot readily break loose. It later may undergo organization and canalization.

In this connection, it is apparent that whereas a completely thrombosed vein, with or without an associated thrombophlebitis, will cause symptoms of venous obstruction peripheral to the thrombosis, the really dangerous lesion, the propagating thrombus, will cause only partial venous obstruction and may give slight, if any, symptoms. It is also obvious that when a propagating thrombus breaks off there is no reason why another thrombus cannot readily reform and break off again, causing another embolus, as is frequently known to occur. Furthermore, it is evident that while a sluggish circulation favors the development of the primary peripheral thrombosis and the secondary propagating thrombus, so an increased venous circulation or violent motion of the vein walls would tend to break off the propagating thrombus.

As attention has become focussed on the propagating or floating thrombus as the cause of pulmonary embolus it has become increasingly apparent that a majority of these thrombi originate in the legs, in the femoral vein or its tributaries. Even in cases in which there has been evidence of local thrombophlebitis elsewhere, as for example, cases of pelvic sepsis or appendiceal abscess, postmortem examination has frequently shown that the source of the pulmonary embolus was from a thrombosis in the leg rather than from the area of local sepsis. The actual incidence of venous thrombosis in the leg in patients who have had pulmonary emboli is almost impossible to estimate accurately,

\* The patients in the cases reported in this paper were all treated in civilian practice at Newton, Massachusetts, before the author entered the military service.

for in many cases the legs have not been specifically examined for the possibility of venous disturbance, and even when examined the clinical symptoms are often so slight as to make the diagnosis questionable. The accumulating operative and postmortem evidence, however, indicates that a large percentage, if not almost all, pulmonary emboli originate from thrombosis occurring in the femoral venous system.

The treatment of pulmonary embolism has been approached in general from three different angles: First, treatment directed against the emboli themselves after they have lodged in the lungs; secondly, treatment of emboli prophylactically by preventing the formation of the original peripheral thrombosis and the secondary thrombus; thirdly, preventing the secondary, propagating thrombus from breaking off into the general circulation by mechanically occluding the vein proximal to the thrombus.

As far as the first type of treatment goes, that is treatment of emboli after they have lodged in the lung, practically no important progress has been made, with two possible exceptions, namely, the prophylactic use of the sulfonamides to prevent the development of a secondary pneumonia, and the use of papaverine to relieve spasm in the pulmonary arteries (occasionally a life-saving procedure). The dramatic operation advocated by Trendelenburg, in which the embolus is removed from the pulmonary artery in a patient who is at the point of death, has proven impractical under the conditions which prevail in most hospitals in this country.

The methods of prophylactic treatment of emboli aimed at preventing the occurrence of peripheral venous thrombosis, have chiefly been of two types: measures designed to combat sluggish venous circulation postoperatively; and the use of anticoagulants to prevent intravascular clotting. Among the measures advised, and in some few clinics faithfully followed out, for stimulating the peripheral circulation,

the most valuable and practical seem to have been the use of compression bandages, various exercises and changes in position designed to minimize obstruction to return venous flow, and the insistence on early and frequent motion of the legs.

The use of heparin, and more recently of dicumarol, to prevent intravascular clotting has been hailed by many as the final solution of the treatment of pulmonary embolism, both before and after peripheral venous thrombosis has occurred. The results so far have been promising. In the few clinics where heparin has been thoroughly used, it has been demonstrated that the use of a carefully controlled continuous heparin drip will, in many cases, prevent venous thrombosis, or at least will prevent the formation of the propagating thrombus. Bauer,<sup>2</sup> for example, reported a group of fifty-three cases of femoral vein thrombosis; twenty-one of these were heparinized for ten days or longer and did not show any increased thrombosis or develop any embolic symptoms; thirty-two received no heparin and of these twenty-four showed extension of the femoral thrombosis and three had massive pulmonary emboli, of which two were fatal. In general, although no deaths from pulmonary embolism have been believed to occur during adequate heparinization, emboli and occasional fatalities have occurred in patients treated with heparin after heparinization was stopped. This was presumably due to the formation of a propagating thrombus after the influence of the heparin had been removed. There are also other drawbacks to the use of heparin. It is of very little use, as Bauer points out, once the propagating thrombus is fully developed. Moreover, its wholesale use prophylactically in postoperative cases is for practical purposes out of the question due to the expense of the drug and the technical difficulties of administering it continuously, in adequate dosage, while at the same time avoiding overdosage with its danger of serious hemorrhage. These difficulties have also prevented its use in

the average hospital, many of which do not have the facilities necessary to maintain adequate heparin technic.

The discovery of dicumarol, which is inexpensive and can be administered orally, has overcome some of these objections to the wholesale use of an anti-coagulant drug prophylactically. In 497 surgical cases recently reported from the Mayo Clinic<sup>3</sup> in which dicumarol was given prophylactically, the results were extremely encouraging; ninety-one cases of postoperative pulmonary embolism or infarction were treated with dicumarol with no fatalities and only two recurrent emboli, (in both of which cases the ideal prothrombin level had not been obtained with the drug treatment). Sixty-four patients with postoperative thrombophlebitis were similarly treated with no fatalities and only two subsequent emboli; 302 surgical patients with no complications were treated postoperatively with dicumarol without encountering any instances of thrombophlebitis or pulmonary embolism. The difficulties encountered were chiefly in administering the dose of the drug so that an adequate elevation of prothrombin time was obtained without at the same time causing spontaneous bleeding. Spontaneous bleeding in this series occurred in forty-seven patients (10 per cent) and was classified as of moderate to severe degree in eighteen, with one fatality from intestinal hemorrhage. In a few cases<sup>20</sup> it was not possible to obtain a satisfactory anti-coagulant effect with what was considered a safe dosage. In spite of its promising action, therefore, the use of dicumarol is still associated with enough difficulties and dangers to lead the average surgeon to use it cautiously and in selected cases.

The last method of treating pulmonary emboli, namely, preventing a propagating thrombus which has already formed from breaking off into the general circulation by occluding the vein proximally, is the method which up to the moment has appealed to us as the most practical life-saving procedure, because of its simplicity,

its safety, and the possibility of offering immediately to the patient and his family positive assurance against recurrence or fatality. The operative procedure involved is of such a minor nature that it can be done safely even with critically ill patients. Local anesthesia is entirely satisfactory. The usual technic is simple (assuming always an adequate knowledge of the regional anatomy): Locate the involved vein, open it, remove enough of the thrombus to establish how far it extends proximally (it is not necessary to remove all the thrombus), and finally, ligate the vein proximally close to its junction with the next larger vein. Provided the ligation is close to the junction, any small floating thrombus which might form proximally to the site of ligation would be promptly carried away by the swift flow of blood in the larger vein (usually a vein of the size of the iliac or larger) before it could grow to any dangerous size.

This procedure has usually been applied to the femoral vein, because as noted above it is in this vein that most postoperative propagating thrombi are found to occur. However, occasionally thrombi may be found and removed in other veins, up to and including the vena cava. The technic of approach to the femoral vein need not be described except to mention that it is usually exposed at the upper end from the saphenous junction to below the profunda and that it is well to keep in mind that in this area the femoral vein and artery are enclosed in a common sheath presenting a structure which when first exposed may appear to be the vein (or artery) alone. Care, of course, must be taken not to injure the femoral nerve or its branches. A good description of the procedure in detail has been given by Homans<sup>4</sup> who started advocating femoral ligation for pulmonary embolism in 1934.

The difficulty with this method of treatment is not, however, in the operative procedure, but in the diagnosis. To be most effective it should obviously be applied before the propagating thrombus

has thrown off any emboli and that presents a considerable problem, inasmuch as the majority of propagating thrombi cause slight if any clinical symptoms until emboli are thrown off. Even when the presence of a thrombus is suspected, an accurate diagnosis of its presence, and even more of its location is difficult to make clinically. Although in many cases there may be suggestive signs, such as minor degrees of swelling or soreness of one leg, a positive "Homans sign," or unexplained postoperative fever, these are rarely conclusive, but merely indicate the need of applying some more definite diagnostic test. In the past various complicated diagnostic procedures were suggested, but none were very satisfactory until in 1940 Dougherty and Homans,<sup>4</sup> following the work of Dos Santos,<sup>9</sup> in 1938, reported the use of venography in diagnosing a case of recurrent pulmonary emboli which they found by this method were arising from a thrombus in the left femoral vein. At about the same time Bauer reported his more extensive experience with venography in the diagnosis of femoral thrombi in Sweden. At first it seemed that this procedure completely filled the need for a diagnostic test by which the presence and exact location of femoral thrombi could be shown accurately and in time to be of value, but further experience has shown that not even this diagnostic test is completely satisfactory, although in most cases it is extremely helpful and in some instances conclusively establishes the diagnosis.

The question may still be raised by some whether femoral ligation should be advised in all cases when the presence of a propagating thrombus has been diagnosed. This question receives some backing from the fact that statistics indicate that only 20 per cent of patients who have had a propagating thrombus (as indicated by their having thrown off a small pulmonary embolus) subsequently succumb to a fatal pulmonary embolism. The argument loses its appeal, however, when the statistics

are read the other way and it is noted in the Mayo series, of the 343 patients who died from pulmonary emboli, 33 per cent or 114 were given warning of a fatal embolus by a preceding non-fatal embolus and could have undoubtedly been saved if femoral vein ligation had been done routinely after the first embolus.

The technic and significance of venography has been thoroughly viewed by DeBailey et al. in a recent paper.<sup>8</sup> The exact procedure followed has varied with the individual surgeon and many of the technics reported seem unnecessarily complicated. Homans and Dougherty advise cutting down on the lesser saphenous vein behind the external malleolus and tying in a transfusion cannula. The dye is then injected through the cannula and washed in with a saline infusion. Starr et al.<sup>5</sup> use a similar technic. Linton<sup>6</sup> advises injecting the superficial vein just inside the internal malleolus and uses a blood pressure cuff around the lower leg inflated to a pressure of 20 mm. of mercury, which forces the dye into the deep venous system. Both of these methods give excellent silhouettes of the deep venous system but do not simultaneously fill the superficial system.

The method which we have used with considerable satisfaction is to inject the dye into the superficial vein at the internal malleolus or into one of the other superficial veins of the foot. A size 19 needle is used as in ordinary intravenous injections and usually it is not necessary to cut down on the vein. No pain is caused if novocaine is injected into the skin and if the needle is fully in the vein. A blood pressure cuff is placed around the upper, not the lower leg, as high as possible up into the groin and inflated to 20 mm. of mercury at the time of the injection. By this method the dye is held in both the superficial and deep systems during the x-ray exposure, giving a comparative silhouette of both systems simultaneously. We have found that this comparative picture gives additional valuable diagnostic information. In the normal venogram produced by this



method of injection three main venous trunks should be visible in the upper leg—the saphenous medially and the double

determined only by comparing the venogram of the involved vein with a venogram of the same vein on the other (normal) leg.

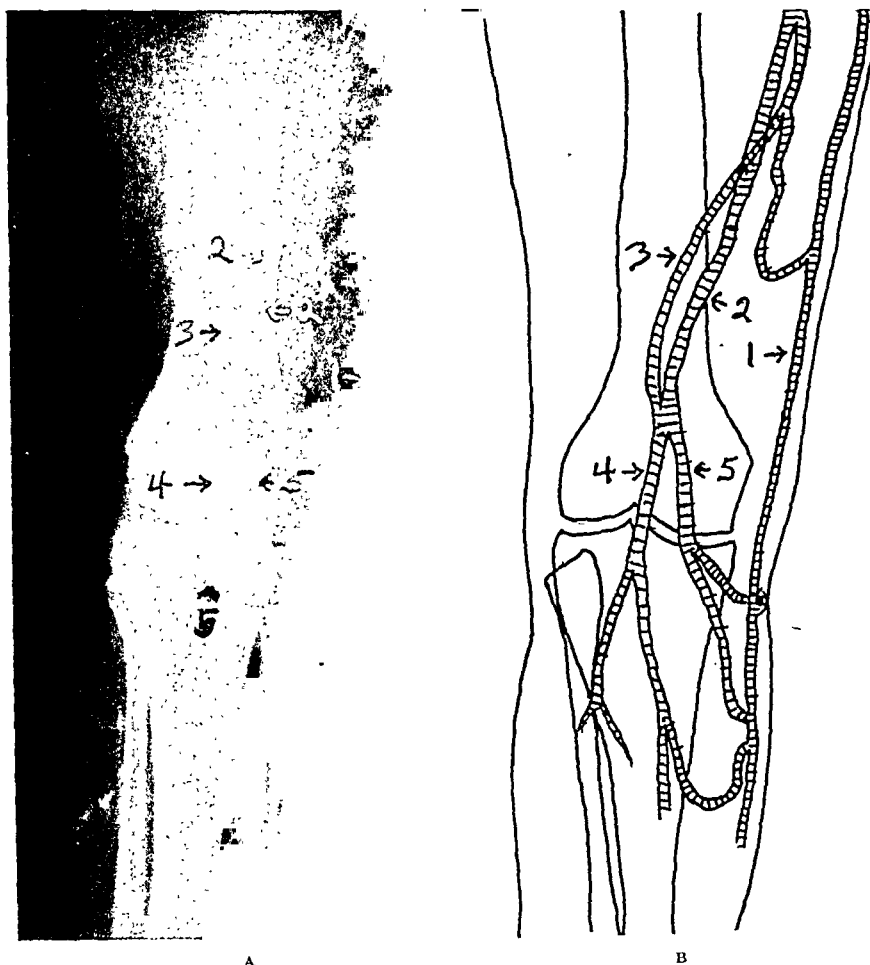


FIG. 1. A, normal venogram: 1, saphenous vein; 2, femoral vein; 3, profunda vein; 4, popliteal vein; 5, anterior and posterior tibial veins. B, normal venogram: 1, saphenous vein; 2, femoral vein; 3, profunda vein; 4, popliteal vein; 5, anterior and posterior tibial veins.

shadow of femoral and profunda centrally. (Fig. 1.) The absence of one of these shadows is of great importance diagnostically. Similarly in the lower leg the three main systems of internal saphenous, anterior and posterior, tibial should normally be present. It is of great importance to have venograms of both legs done with identical amounts of dye and identical technic, for in some instances when the floating portion of the thrombus only partially obstructs the vein, the vein shadow will not be absent but merely narrowed. Such narrowing can be definitely

This situation applied to two of our cases in both of which the diagnosis of a femoral thrombus was confirmed at operation.

Although we have found venography very valuable, a word of caution must be issued against its wholesale, indiscriminate use. The dyes used are far from innocuous substances if used improperly, as evidenced by the recent reports of occasional fatalities from iodide poisoning following use of intravenous dye in pyelography. It is a wise precaution to test every patient for iodide sensitivity by having them hold a few drops of the solution on their tongue

before using the solution for intravenous injection. A second possible danger is the possibility of the dye itself causing irritation of the vein when it is injected leading to new and extensive thrombosis in previously healthy veins. Rare instances of this complication having occurred have been reported. However, when an increased thrombosis follows an intravenous injection it is difficult to prove that the thrombosis would not have occurred anyway, even if the injection had not been given. In general, although the danger must be kept in mind, it must also be remembered that the dyes used in venography have been used for many years in intravenous pyelography without causing serious vein irritation. Starr,<sup>5</sup> in fact, points out that experimentally the intima of the femoral vein has been exposed to the intravenous dyes used for as long as twenty-four hours "without gross evidence of injury"; and in tests which we conducted we found that all x-ray evidence of remaining dye in the veins had vanished within a few minutes after it had been injected.

#### CASE REPORTS

In the five cases reported below propagating femoral thrombi were accurately diagnosed and successfully treated by using the procedure of venography and femoral ligation during a period of three months from the time our attention was first attracted to these methods of treatment. Further work was cut short by entry into military service. In three of the patients it was not until after the patient had suffered one or more pulmonary emboli that the diagnosis was made, although the diagnosis was suspected earlier in one and not seriously considered because of the minor nature of the symptoms. In the other two cases the diagnosis was made before there was any evidence of pulmonary embolism and prophylactic femoral vein exploration was performed with removal of a femoral thrombus.

CASE 1. Mrs. E. J., age sixty-four, was admitted to the Newton Hospital, December 29,

1941, for treatment of a compression fracture of the second lumbar vertebra sustained two days previously when she had fallen backwards into a bath tub. There was no evidence of injury to the legs and practically no external evidence of trauma. The patient was placed on a hyperextension frame for five days. A posterior plaster shell was then applied from hips to shoulders, and anchored in place with circular plaster bandages across the pelvis and chest. The entire abdomen was left exposed because of a tremendous ventral hernia but the cast was steadied by placing a bed pillow in the abdominal opening with a scultetus abdominal binder going around the cast and the pillow. This apparatus immobilized the spine satisfactorily and allowed the patient to turn freely in bed and exercise her legs.

The patient's hospital progress was uneventful until January 19th, sixteen days after application of the cast when she complained of pain in the left upper quadrant. Her temperature rose to 100.4°F. for a few hours and then continued normal. There was no change in pulse or respirations. The white count rose to 13,900 with a normal differential. The pain was not very severe requiring no medication and there was no cough. At the time the probability of a small pulmonary embolus was not suspected.

Ten days later the patient complained of similar pain in her right quadrant. In a few hours this became increasingly severe and localized in the right lower chest. Her temperature rose to 102°F., pulse to 100, respirations to 30. The patient began to cough and raised bloody sputum. The white count rose to 19,000 with a differential of 23 unsegmented polys, 66 segmented polys, 10 lymphocytes and 1 monocyte. The patient had had a slight cold and a diagnosis of pneumonia was made which was confirmed when an x-ray showed diffuse consolidation of the entire right lower lobe. The sputum, however, showed very few pneumococci.

In accordance with the diagnosis of pneumonia the patient was placed on full doses of sulfadiazine but in spite of a blood level of 12.2 mg. per cent, the temperature, pulse, and respirations remained unchanged for five days and the cough and bloody sputum were unchanged. When the pain in the right chest, occasional bloody sputum and low grade temperature continued for ten more days we were

convinced that we had been dealing with a septic pulmonary embolus rather than a true

patient was allowed to move more freely in bed. Five days later, she suddenly had a severe

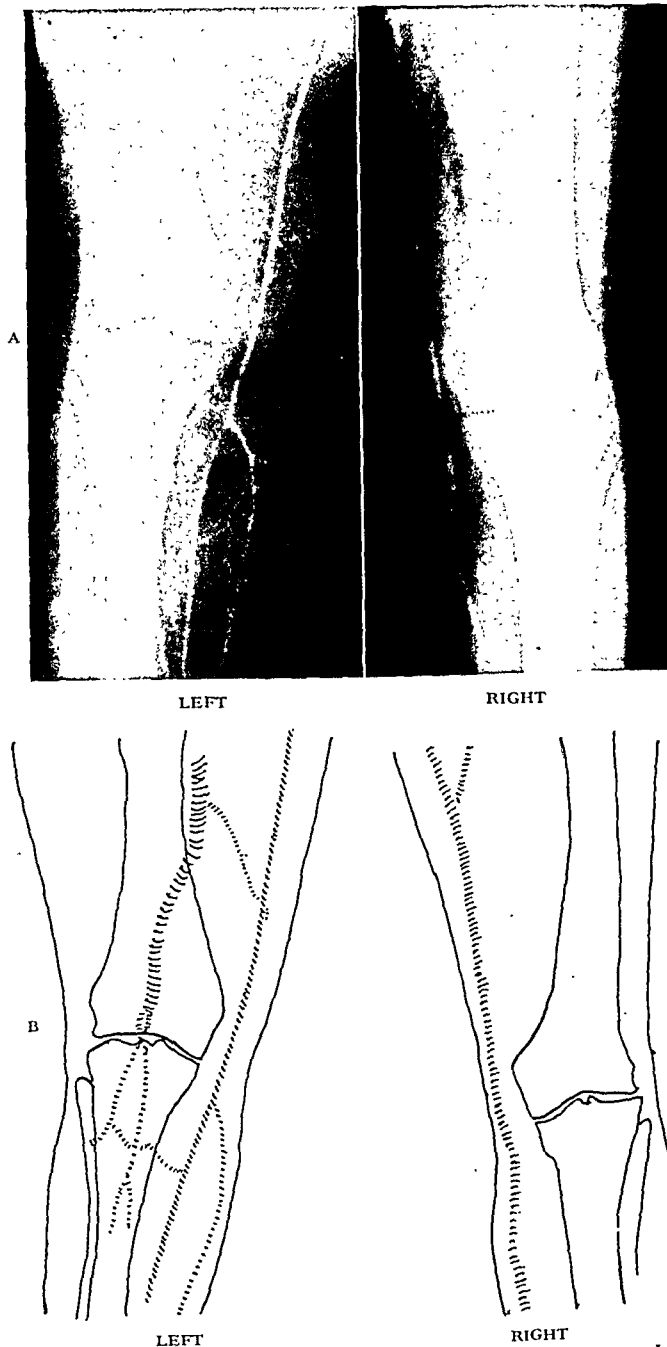


FIG. 2. A. Case 1. Mrs. E. J. *Left*, venogram of right leg, normal; *right*, venogram of left leg; saphenous vein only filled. B, Case 1. *Left*, venogram of right leg, normal; *right*, venogram of left leg; saphenous vein only filled.

pneumonia. The difficulty was that there was no obvious source for an embolism.

On February 16th, three weeks after this episode the body cast was removed and the

pain in her left chest with acute dyspnea. Her pulse rose to 160, respirations to 45. There could be no doubt about the diagnosis of a typical severe pulmonary embolus. As is com-

mon in acute embolus, x-ray did not immediately demonstrate the infarct in the left lung although it outlined clearly the residual healing infarct in the right lung. An x-ray taken one week later clearly showed the new infarct. Again the patient's legs were carefully examined but showed absolutely no edema or tenderness. However, on questioning a story was elicited of several transitory attacks of fever, redness and swelling of the left leg occurring at intervals during the past ten years, suggesting a recurrent phlebitis of the left leg. With this lead, bilateral venograms were immediately done, injecting 20 cc. of diodrast in the dorsal veins of each foot. A complete block of the left popliteal and femoral vein was clearly demonstrated while at the same time control venograms of the right leg showed good filling of the femoral and saphenous systems. (Fig. 2.) The left saphenous vein was shown to be patent. On this basis ligation of the left femoral vein below its juncture with the saphenous was advised. A few hours later the left femoral vein was explored through a vertical incision extending for 3 inches distal to the saphenous opening. Local anesthesia was used. On opening the vein it was found to be completely occluded by a soft clot. There was little evidence of inflammation of the vein wall. The thrombus was removed proximally up to the saphenous juncture where free circulation was demonstrated. The femoral vein was then ligated close to the saphenous and a short segment of the vein excised. This segment together with part of the thrombus was saved for examination.

The report of the pathological examination of these specimens was as follows: "Specimen (1) consists of 4 to 5 mm. segment of femoral vein which has a thin wall. The lumen is empty. (2) A small irregular fragment of reddish and pinkish gray thrombotic matter which appears to have come from the vein and measures 0.8 mm. long and 0.6 cm. in diameter. Microscopical examination of section through the femoral vein shows slight irregular thickening of the wall. There is a small patchy lymphocytic infiltration present. Section through the thrombotic matter shows it to be of variegated type.

"Diagnosis: (1) Segment femoral vein. Slight chronic phlebitis. (2) Variegated thrombus." (Such loose thrombi in veins showing little evidence of phlebitis are typical of the condition found in propagating thrombi.)

Following this procedure the patient developed slight edema of the left leg which cleared up completely in four weeks. The most recent pulmonary infarct in the left chest cleared slowly and for this reason the patient was not allowed out of bed until three weeks after the ligation. She was discharged to a nursing home three days later. At the last examination, six months after the operation she had returned to her home in Connecticut and was living a normal life with no discomfort or edema in either leg.

CASE II. Mr. P. Z., age fifty-eight was admitted to the Newton Hospital, February 7, 1942, for treatment of swelling and redness of the right lower leg. Two weeks previously he had slipped and fallen on the stairs while working. At this time he felt a pain in his right calf. Two days later his foot began to swell and then the entire lower leg became markedly reddened and swollen to the knee. He had no chills or fever and little discomfort. The swelling and redness improved with ten days' rest and elevation at home but as soon as he tried walking again the foot became swollen and was cyanotic when kept dependent for any length of time. He was sent into the hospital for paravertebral block with a diagnosis of traumatic thrombophlebitis, right popliteal vein.

On admission to the hospital his general examination was essentially normal, blood pressure 120/75, urine and blood studies were normal. Local examination showed the right lower leg reddened, tense and swollen with slight tenderness over the calf only. The superficial veins below the knee were obviously dilated in comparison with the left leg.

Twelve hours after admission to the hospital, before any treatment had been given, he awoke in the night with severe pain in the left chest and acute dyspnea. His pulse was 120, respirations labored. The attack subsided in two hours and the patient felt well the next morning, but showed a few râles at the left base which had not been there twenty-four hours before. Immediate x-ray showed no consolidation, but a later x-ray showed a healing infarct at the left base. (The lung changes, which follow an embolus and produce an infarct do not develop fully for several hours or days and obviously x-ray changes are not demonstrable for a similar period of time.) Electrocardiographic studies were essentially

negative, showing slight left ventricular preponderance but no evidence suggestive of coronary disease or a large pulmonary embolus.

Although it was believed definitely that this patient had had a small pulmonary embolus our first reaction was to follow the old *laissez-faire* school and take our chances on the future. Local treatment—bed rest, heat and elevation—was supplemented with two paravertebral sympathetic blocks but after two weeks the right leg still became swollen and cyanotic whenever it was hung down for even a few minutes, and the dilatation of the superficial veins persisted even with the leg in bed. This seemed to indicate a fairly extensive thrombosis of the deep venous system probably extending up the femoral vein to the saphenous. At this time, therefore, it was decided to explore and ligate the femoral vein for the dual purpose of preventing further pulmonary emboli and restoring normal circulation to the lower leg (which would be accomplished by interruption of the sympathetic innervation of the femoral vein attendant upon ligation and excision of a segment of the vein).

On February 21st, two weeks after admission, operation was performed, exposing the right femoral vein for a distance of three inches below its junction with the saphenous vein. A vertical incision was used. A firm partially organized thrombus was found filling the femoral vein up to but not beyond the profunda branch. Normal circulation was demonstrated in the profunda and saphenous veins. The thrombus was removed proximally up to the junction with the profunda vein and the femoral vein was then ligated just below its junction with the profunda. A half inch segment of femoral vein showing considerable evidence of periphlebitis was removed. (It was this periphlebitis, of course, rather than the thrombus inside the vein which was responsible for the edema, etc., of the lower leg, for as noted above the thrombus alone may be present without causing any definite peripheral edema.)

Following this operation the redness and edema in the lower leg rapidly subsided. A venogram was done ten days postoperatively and showed good compensatory circulation through the saphenous vein. Two weeks after operation the patient was walking about freely with absolutely no edema or cyanosis and went home one week later ready to return to work. The prompt relief of the edema and cyanosis was particularly striking since this patient

had had four weeks of conservative treatment in bed before femoral ligation without relief of the edema.

CASE III. Mrs. E. D., age fifty-seven, was admitted to the Newton Hospital April 1, 1942, for treatment of an acute pulmonary embolus in the left lung. On December 30, 1941, three months previously, she had been hit by an automobile sustaining a compound, badly comminuted fracture of the left tibia and fibula with destruction of both lower tables of the knee joint. There was extensive subcutaneous tissue damage with considerable trauma to the veins of the anterior and medial aspects of the lower leg in the region just below the knee. An open reduction was performed with satisfactory re-approximation and wiring of the comminuted fragments of the knee joint. A circular plaster cast was then applied extending up to the upper thigh.

There was no infection of the wound and the patient ran a smooth course following the operation except for a low grade temperature just over 99°F. which persisted for over two weeks. Also, on the tenth postoperative day the patient suddenly developed slight swelling of her thigh inside the cast, so that her cast suddenly felt tight. The wound was entirely clean and there was no evidence of deep infection such as swollen inguinal nodes. The possibility that the swelling might have been caused by a mild thrombophlebitis of the popliteal and femoral veins was considered, but the swelling subsided in a few days and it was believed that no further treatment was indicated. The question of doing a prophylactic ligation of the femoral vein to guard against the danger of a pulmonary embolus was raised, but because of the minor nature of the patient's symptoms it was voted down. When two and a half months later the patient left the hospital walking on crutches the incident had been practically forgotten.

When the patient got home she began to receive more vigorous physiotherapy than she had been getting in the hospital. After a few days she complained that this caused some soreness in her knee and lower leg so that orders were given to have it administered less violently. On this régime the soreness subsided and the patient began to walk with a brace without her crutches. Then suddenly one night ten days after leaving the hospital and three months after her operation, she awoke with severe pain in the left chest, cough and acute

dyspnea—the typical picture of a pulmonary embolus.

On admission to the hospital the patient was critically ill and for the first twenty-four hours

left femoral vein did not fill in the venogram. The left profunda and the left saphenous were larger than normal, a situation which had been noted in a previous case (Case IV reported

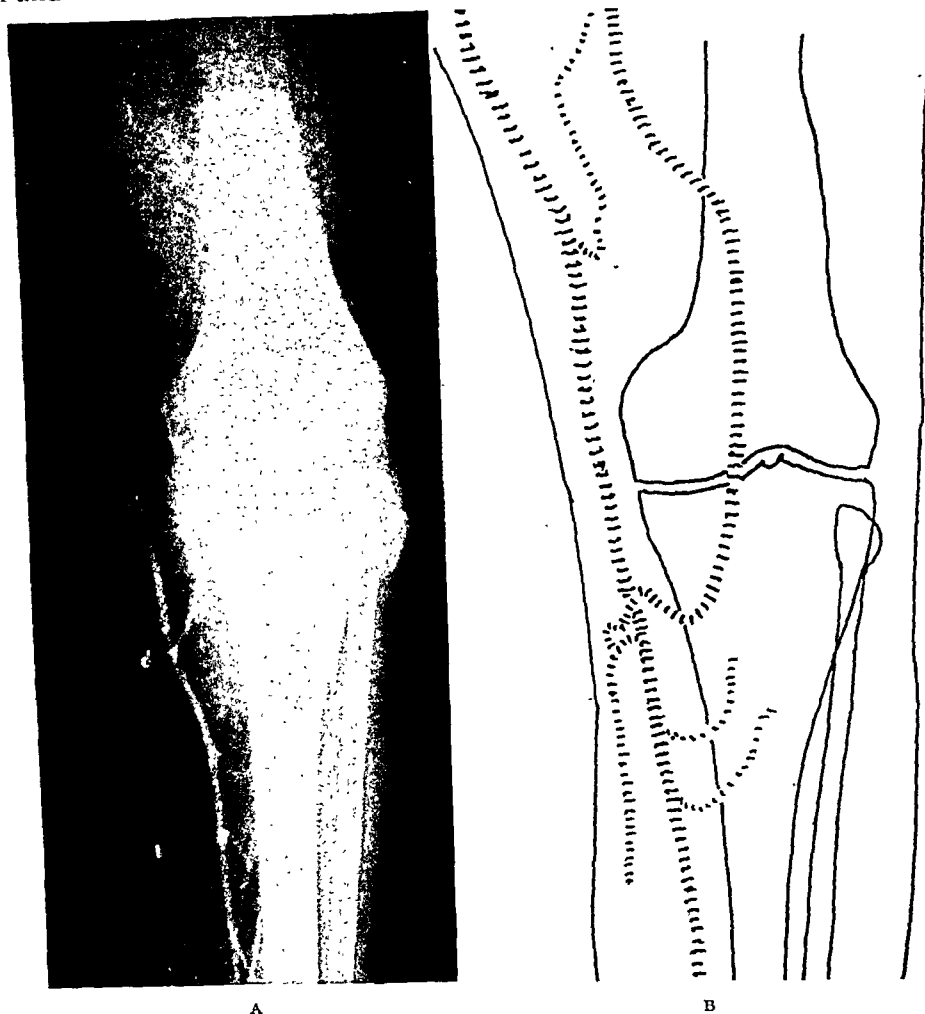


FIG. 3. Case III. A, venogram of left leg; popliteal and anterior tibial veins not filled. B, venogram of left leg; popliteal and anterior tibial veins not filled.

was placed in an oxygen tent. The temperature rose to 103.4°F. in twenty-four hours but further sepsis was controlled by the use of full doses of sulfadiazine orally. X-ray studies twenty-four hours after admission and at later dates confirmed the presence of a large area of pulmonary infarction in the lower left lung. On the basis of the history it was believed certain that the origin of the embolus was a propagating thrombus of the left femoral vein probably originating from a traumatic thrombophlebitis of the anterior tibial venous system. Bilateral venograms were done which confirmed this diagnosis by demonstrating lack of filling of the left anterior tibial system. (Fig. 3.) The control venogram showed normal filling of the right anterior tibial system. The

below) in which a propagating thrombus had been removed from the femoral vein.

Because of the patient's critical condition exploration of the left femoral vein was postponed for three days. On April 4th, however, the left femoral vein was exposed under local anesthesia through the usual vertical incision. On opening the vein close to its juncture with the saphenous no thrombus was found but it was demonstrated that while there was a free retrograde flow of blood from the iliac vein back into the femoral there was no flow of blood from below, indicating a complete block of the lower end of the femoral system. It was believed that originally the propagating thrombus had probably occupied the entire femoral vein but that the portion occupying the upper

femoral had broken off to produce the recent embolus and had not yet reformed. Further exploration was not done but the femoral vein

was sent home walking (with crutches) and with less edema of her foot than she had had at any time since she had been out of bed after

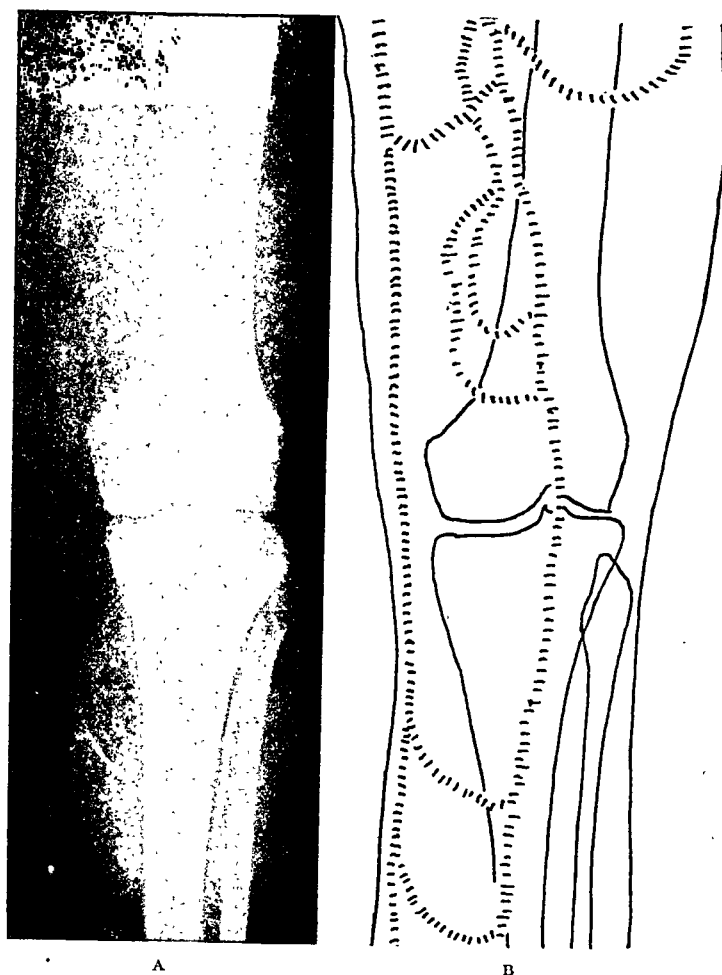


FIG. 4. Case IV. A, venogram shows single narrow trunk instead of broad double shadow of femoral and profunda veins normally seen. B, venogram shows single narrow trunk instead of broad double shadow of femoral and profunda veins normally seen. Note abnormal collateral veins.

was ligated just below the profunda, removing a small half inch segment of the vein. (In performing this operation we remove a segment of the vein routinely, believing that such removal with its interruption of sympathetic fibers relieves the edema of peripheral thrombophlebitis, and will also act as insurance against the formation of edema which might result from periphlebitis following exploration of the femoral vein. In this case there was some edema of the foot present before operation and this had almost entirely disappeared within the next two weeks.)

Because of the large pulmonary infarct this patient was not allowed out of bed for two weeks after the operation. One week later she

her accident. During the subsequent five months the patient continued in good health and gradually regained good function of her knee, although the enforced bed rest necessitated by the pulmonary infarction slowed up the motion of her knee considerably. In this connection it is interesting to speculate how much better off the patient would have been in every respect if prophylactic femoral ligation had been done when it was first considered at the time when the patient first showed suggestive signs of femoral thrombosis, ten days after her injury.

CASE IV. Mrs. E. M., age fifty-two, was admitted to the Newton Hospital, February 17 1942, for repair of a huge ventral hernia in an

old cholecystectomy scar. In her past history she had had four laparotomies, two of which were cesareans, one appendectomy and finally the cholecystectomy, done ten years ago. She had noticed varicose veins in both legs but never had a milk leg or any symptoms suggestive of phlebitis. Physical examination on admission was negative except for the large ventral hernia, marked general obesity, and moderate varicose veins of both legs.

On February 19th, under spinal anesthesia the ventral hernia was repaired. Because of the large size of the hernia defect and the difficulty in approximation, a tight scultetus binder was ordered and kept tightly in place for three weeks.

Postoperatively the patient ran a febrile course with temperature between 100 and 101°F. daily. This was accounted for by a cystitis which developed from an inlying catheter and from a stitch abscess. The stitch abscess drained on the tenth day but continued to discharge pus for two weeks.

On March 5th, on her fourteenth postoperative day, she suddenly complained of pain in her left calf. There was very slight tenderness of the calf with a positive Homan's sign but no edema or redness and no increased fever or chills. Bilateral venograms were immediately done using 10 cc. of diodrast in each leg. The left popliteal vein did not fill and the left femoral was narrowed while the left saphenous was larger than normal. (Fig. 4.) This indicated to us a thrombophlebitis of the left popliteal vein with a propagating thrombus in the left femoral vein.

With this definite evidence of thrombosis in the leg it was decided to do an immediate prophylactic ligation of the left femoral vein. Approximately twelve hours after the onset of the leg pain the left femoral vein was explored through a vertical incision extending 3 inches distally from the saphenous opening. The vein was opened and the venous flow from below found to be completely obstructed. There was a considerable amount of soft clot which was removed with suction. The absence of phlebitis and the presence of a soft thrombus which was attached to the vein wall confirmed the preoperative diagnosis of propagating thrombus of the femoral vein. A half-inch segment of the vein with attached clot was excised and the ends of the vein ligated.

The pathological report of the specimen of vein and thrombus removed was as follows;

"Specimen consists of a short resected segment of vein 0.7 cm. long and 0.5 cm. in diameter. The lumen is occluded by thrombotic material. Microscopical examination of section through the segment of femoral vein shows the lumen to be occluded by variegated thrombotic material. The wall presents moderate irregular fibrous internal thickening and shows a light diffuse infiltration of lymphocytes and a few neutrophils.

"Diagnosis: Femoral vein. Thrombophlebitis."

Following the operation there was slight edema of the lower leg for ten days. Most of this edema seemed to be centered over an area on the dorsum of the foot where a small amount of diodrast had been injected outside the vein and it was believed that the edema was probably due to this rather than to the ligation of the femoral vein. The patient was allowed out of bed on the eleventh day after ligation and went home one week later. The edema of the leg had almost disappeared except for the local area on the dorsum of the foot when she left the hospital and had entirely cleared up one month later.

CASE V. Mr. W. H., age sixty-eight, was admitted to the Waltham Hospital, March 8, 1942, with a general peritonitis due to a ruptured appendix of several hours' duration. His past history was negative except for a bilateral hernia repair twenty years ago.

Shortly after admission appendectomy with drainage was performed and 12 Gm. of sulfanilamide crystals introduced into the peritoneum. Sulfadiazine was given by mouth in full doses for the next two weeks. He had a very stormy postoperative course marked by almost continual delirium, recurrent vomiting and several episodes of bleeding from his wound, culminating in complete evisceration of the incision on the twenty-second postoperative day. This was resutured. Following resuture (and the omission of the sulfadiazine) he ran a smooth postoperative course and was up and walking ten days after this secondary operation. Five days later he suddenly noticed that his right ankle and leg became swollen and cyanotic when he put his legs down. A clinical diagnosis of probable thrombosis of the right femoral vein was made with a possibility (in view of his recent pelvic sepsis) that the thrombus might extend even higher into the right iliac vessels. A bilateral venogram was done and settled the diagnosis definitely by revealing



a complete block of the right femoral vein with a patent right saphenous vein (indicating that the block did not extend above the junction of the saphenous with the femoral vein).

With this definite diagnosis and in view of the patient's postoperative course it was believed that this patient had a better than average chance of developing a pulmonary embolus. Accordingly exploration of the right femoral vein was advised. On April 18th, under novocaine anesthesia the upper end of the vein was exposed through the usual vertical incision. The vein was opened and found to be occluded up to but not beyond the saphenous opening by a firm organized thrombus lightly attached to the vein wall. After this thrombus was removed the iliac vein was thoroughly suctioned and no further clot found. The femoral vein was then ligated just distal to the saphenous vein and a half inch segment of the vein excised. The specimens were sent to the pathologist for examination and the report returned, "Organizing thrombus of femoral vein with slight thrombophlebitis of vein wall."

Following this femoral ligation the patient made an excellent recovery. He was allowed out of bed two days after the operation and sent home walking freely and with no edema of his foot seven days later.

In this case, as in Case iv, femoral exploration and removal of the threatening thrombus was done entirely prophylactically as soon as the diagnosis was made and before the patient had a chance to develop a pulmonary embolus. In neither case was the patient bothered by the procedure and the hospital stay was shortened rather than lengthened due to the prompt control of the thrombophlebitic edema which followed the partial resection of the upper femoral vein.

#### COMMENT

In reviewing our experience with these five cases certain features attracted our particular interest:

First, the diagnosis of femoral vein thrombosis when it is not associated with obvious thrombophlebitis—and the cases not associated with obvious thrombophlebitis are certainly the most dangerous from the point of view of pulmonary embolism—is often difficult to make because of the minor character of the clinical

symptoms. If the possibility is kept in mind, however, the diagnosis can often be suspected and the suspicion verified by the use of venography. Positive treatment can then be instituted before a possible fatal pulmonary embolus occurs. In this connection it is worth noting that in one of our cases in which the diagnosis was suspected no further procedures were carried out because of the minor nature of the symptoms with the result that this patient suffered an almost fatal embolus at a later date (at which time the diagnosis of femoral thrombosis was made and femoral ligation and resection successfully performed). In cases in which a pulmonary embolus already has occurred and there is a good chance of another embolus occurring, evidence of femoral vein thrombosis should be carefully looked for and even if no evidence is found venography should be done. In one of our patients there were absolutely no clinical signs suggesting any trouble with the femoral vein or its tributaries but a thrombus was located by venography and later removed at operation.

Secondly, the question of the relationship of edema of the leg to femoral vein thrombosis interested us especially. In these few cases it was quite evident that marked edema was present only when there was definite thrombophlebitis in the peripheral veins and was very slight or absent when there was a bland femoral thrombosis, even though the femoral vein was completely obstructed up to the saphenous junction. Postoperatively, there was slight edema of the lower leg for a few days in four of the five patients and in all of them this was associated with signs of some mild thrombophlebitis, as evidenced particularly by some tenderness along the femoral vein. Interestingly enough, in the one case in which marked thrombo- and phlebitis was found at operation the edema disappeared entirely a few days after femoral ligation and partial resection. This probably was due to the interruption of the perivascular sympathetic nerve fibers produced by the resection of the femoral vein. It is evident, therefore, that

simple obstruction of the femoral vein does not produce edema; and if the saphenous or other collateral systems are patent, femoral ligation should not by itself cause edema. Furthermore we suspect that by resecting a small portion of the femoral vein at the time that we do a femoral ligation the probability of postoperative edema of the lower leg is greatly decreased in the same manner that thrombophlebitic edema is relieved. In fact, if Ochsner and DeBailey's theory of thrombophlebitis<sup>7</sup> is correct, interruption of the perifemoral sympathetic chain should be good insurance against the postoperative development of a peripheral thrombophlebitis, which as we have noted above is the chief cause of edema in these cases of venous thrombosis. However, our group of cases is too small to permit drawing any definite conclusion on this point.

A third feature of interest to us in these cases, particularly in the patients who had already suffered a pulmonary embolus, was the tremendous satisfaction we derived from being able to offer these patients a positive, rational form of treatment instead of having to offer them and their families weeks of anxiety and danger with the possibility of sudden violent death threatening. The peace of mind obtained, in addition to the satisfying clinical results, was certainly worth the slight dangers offered by venography or the minor local operation. The contrast between the old and the new method of treatment is brought home forcibly when a patient who has had a near fatal pulmonary embolus is able to leave the hospital walking two weeks later instead of spending anxious weeks in bed and not even being sure then that another embolus may not occur.

#### SUMMARY

1. The etiology and present methods of treatment of pulmonary emboli are reviewed, emphasizing the fact that most emboli are believed to originate from free propagating thrombi in the femoral venous system.

2. The use of femoral vein ligation in the prophylactic treatment of pulmonary embolism and the use of venography in the diagnosis and localization of femoral thrombi are discussed and evaluated.

3. Five cases are reported in which accurate diagnosis of femoral vein thrombi was made largely through the use of venography and in which satisfactory results were obtained by ligating and partially resecting the involved femoral vein. Three of the patients had suffered pulmonary emboli before the femoral vein ligation was performed.

4. In addition to the removal of danger of further pulmonary emboli, the operation of ligation and partial resection of the femoral vein was observed to have a beneficial effect on associated thrombophlebitis when this was present, particularly in the prevention as well as relief of associated peripheral edema.

#### REFERENCES

1. BARKER, N. W., NYGAARD, K. K., WALTERS, WALTERMAN and PRIESTLEY, J. T. A statistical study of postoperative venous thrombus and pulmonary embolism. *Proc. Staff Meet., Mayo Clin.*, 15: 796, 1940; 16: 33, 1941.
2. BAUER, G. A venographic study of thromboembolic problems. *Acta chir. Scandinav.*, 84: 1, 1940.
3. BARKER, N. W., ALLEN, E. V. and WAUGH, J. M. The use of dicumarol in the prevention of postoperative thrombophlebitis and pulmonary embolism. *Proc. Staff Meet., Mayo Clin.*, 18: 102, 1943.
4. DOUGHERTY, JOHN and HOMANS, JOHN: Venography: a clinical study. *Surg., Gynec. & Obst.*, 71: 697, 1940.
5. STARR, ARNOLD, FRANK, H. A. and FINE, JACOB. The venographic diagnosis of thrombophlebitis of the lower extremities. *J. A. M. A.*, 118: 1192, 1942.
6. ALLEN, ARTHUR W., LINTON, ROBERT R. and DONALDSON, GORDON A. Thrombosis and embolism—review of 202 patients treated by femoral vein interruption. *Ann. Surg.*, 118: 728, 1943.
7. OCHSNER, ALTON and DEBAKEY, M. E. Therapeutic considerations of thrombophlebitis and phlebothrombosis. *New England J. Med.*, 225: 207, 1941.
8. DEBAKEY, MICHAEL E., SCHROEDER, GEORGE F. and OCHSNER, ALTON. Significance of phlebography in phlebothrombosis. *J. A. M. A.*, 123: 738, 1944.
9. DOS SANTOS, REYNALDO. Phlébographie d'une veine. Cava inférieure suturée. *J. d'uro.*, 39: 586-587, 1935.

# THE RELATIVE EFFICACY OF PENICILLIN, TYROTHRICIN, STREPTOTHRICIN AND SULFATHIAZOLE ON HEMOLYTIC STREPTOCOCCUS IN WOUNDS OF RABBITS\*

ERWIN NETER, M.D.,

Assistant Professor of Bacteriology, University of Buffalo

ROGER S. HUBBARD, PH.D.

Professor of Pharmacology, University of Buffalo

AND

THOMAS G. LAMBERTI, M.D.

BUFFALO, NEW YORK

THE wave of enthusiasm concerning the usefulness of sulfonamides in the treatment of localized infections has subsided, since it is realized now that these drugs have but a limited therapeutic value and little effect upon micro-organisms in wounds and other localized infections. Interest, therefore, has been focused on anti-biotic substances. The most promising of them are penicillin, streptothricin and tyrothricin. Favorable reports on the effects of locally applied penicillin have been published, among others, by Flory and Flory,<sup>1</sup> as well as by Sophian<sup>2</sup> and Peck.<sup>3</sup> Tyrothricin, which exerts marked anti-microbial activity both *in vitro* and *in vivo*, has been employed as a therapeutic agent in localized infections of man by Rammelkamp,<sup>4</sup> Herrell and Brown<sup>5</sup> and in animals by Bryan, Weldy and Greenberg,<sup>6</sup> Bean, Miller and Heishman,<sup>7</sup> and others. Very recently, Waksman and associates,<sup>8</sup> Robinson,<sup>9,10</sup> as well as Metzger, Waksman and Pugh<sup>11</sup> have studied the effects of streptothricin and obtained very encouraging results both in *in vitro* tests as well as in animal experiments. In order to ascertain the relative efficacy of these compounds, experiments were carried out to determine by comparative studies their action upon group A beta hemolytic streptococcus in artificial wounds of rabbits.

## MATERIALS AND METHODS

Rabbits weighing between 2,200 Gm. and 3,500 Gm. were used in this investiga-

tion. Artificial wounds were produced as described previously.<sup>12</sup> The wounds were infected with an eighteen-hour infusion broth culture of a strongly fibrinolytic group A beta hemolytic streptococcus, isolated from a human source. The strain was susceptible *in vitro* to the action of the anti-microbial agents used in this study. Powder of sulfathiazole, tyrothricin and streptothricin was applied to the entire area of the wound and evenly distributed. When amounts smaller than 10 mg. were used, the drug was mixed with calcium carbonate and disodium phosphate and the total weight brought up to 10 mg. In some experiments a watery suspension of tyrothricin was also employed. Penicillin was used in amounts of 0.05 ml; the sodium salt was dissolved in appropriate amounts of sterile distilled water. It was found that 0.05 ml could be applied to the wound without appreciable loss. After a period of twenty-four hours the drugs were removed from the wounds with a swab. This procedure was adapted after it was found that this manipulation did not result in the elimination of the streptococci present in the wound itself. Material from the wounds was taken with a swab and seeded on 5 per cent human blood agar in Petri dishes. Cultures from the wounds were taken in duplicate. The blood agar plates were incubated at 37°C. for seventy-two hours and the approximate number of hemolytic streptococci was recorded.

\* From the University of Buffalo, School of Medicine, and the Laboratory of Bacteriology, Children's Hospital, Buffalo, New York.

## RESULTS

The findings in thirty experiments, involving 181 artificial wounds in rabbits infected with beta hemolytic streptococcus and treated with sulfathiazole and various anti-biotics, are summarized in Table 1.

TABLE 1  
COMPOSITE RESULTS OF 30 EXPERIMENTS ON RELATIVE  
EFFICACY OF ANTIBIOTICS AND SULFATHIAZOLE  
ON HEMOLYTIC STREPTOCOCCUS IN WOUNDS  
OF RABBITS

Treatment	No. of hemolytic streptococci in wounds after treatment for 24 hours			
	Many	Moderate No.	Rare	None
No. of experiments				
Sulfathiazole, 100 mg.....	15	1	0	0
Tyrothricin, 25 mg.....	0	5	0	1
10 mg.....	1	8	1	0
1 mg.....	5	4	0	0
Streptothricin, 100 mg....	0	4	3	0
25 mg....	0	5	2	1
10 mg....	0	7	1	1
1 mg....	4	5	0	0
Penicillin 5,000U.....	0	3	3	7
250-500 U.....	5	11	8	4
25-100 U.....	11	8	3	2
2.5-5 U.....	11	1	0	0
None (control).....	30	0	0	0

It may be seen from this table that many hemolytic streptococci were present without exception in all of the thirty untreated wounds. Application of 100 mg. of sulfathiazole to infected wounds resulted in the reduction in the number of hemolytic streptococci in only one out of sixteen experiments. This observation of the ineffectiveness of sulfathiazole under the conditions of these experiments confirms previous findings with sulfanilamide.<sup>12</sup> In contrast to sulfathiazole, three anti-biotic substances, namely, tyrothricin, streptothricin and penicillin, were found to be effective under the same experimental conditions. It may be seen from the table that 25 mg. of tyrothricin caused a reduc-

tion in the number of hemolytic streptococci in all of six experiments and 10 mg. of tyrothricin in nine out of ten experiments. It is also evident that smaller amounts (1 mg.) of this therapeutic agent are less effective than larger quantities (10 and 25 mg.). It is interesting to note that 1 mg. of tyrothricin produced a reduction in the number of streptococci in four out of nine experiments and thus proved to be somewhat more efficacious than 100 mg. of sulfathiazole. Hence, tyrothricin under the conditions of this experiment proved to be at least 100 times more effective than sulfathiazole.

Streptothricin, too, exhibited anti-streptococcal activity in these experiments. It may be seen from Table 1 that this compound in amounts of 1 mg. to 100 mg. caused a reduction in the number of streptococci in twenty-nine out of thirty-three experiments. In all of twenty-four experiments 10 mg. of streptothricin or more was effective. Like tyrothricin, streptothricin proved to be at least 100 times more efficacious than sulfathiazole.

The study of the anti-streptococcal activity of sodium penicillin upon hemolytic streptococcus in artificial wounds of rabbits revealed the following: Penicillin in amounts of 2.5 to 5 units had no effect in eleven out of twelve experiments. Somewhat larger amounts, namely 25 to 100 units caused a reduction in the number of hemolytic streptococci in thirteen out of twenty-four experiments, in amounts of 250 to 500 units in twenty-three out of twenty-eight experiments and in amounts of 5,000 units in all of thirteen experiments. It is evident, therefore, that 25 to 100 units of penicillin exerted greater anti-streptococcal activity than 100 mg. of sulfathiazole. Compared with streptothricin and tyrothricin, 2 to 5 units of penicillin yielded somewhat poorer results than 1 mg. of the former substances.

## COMMENTS

Well known is the fact that the *in vivo* activity of disinfectants, chemotherapeutic

substances and anti-biotics does not always parallel their action *in vivo*. For instance, prontosil is much more efficacious in infections of man and animals than in artificial culture media. On the other hand, it was reported recently that sulfonamides and azochloramid act synergistically *in vitro* and no such effects were demonstrated either in mastitis caused by group C hemolytic streptococcus or in experimental wound infections in rabbits due to group A hemolytic streptococcus.<sup>13,14</sup> Consequently, it is imperative to study any new chemotherapeutic agent both *in vitro* and *in vivo*. The investigation reported here was undertaken to determine the relative efficacy under *in vivo* conditions of sulfathiazole, penicillin, tyrothricin and streptothricin against group A beta hemolytic streptococcus. It was found that the anti-biotics, penicillin, tyrothricin and streptothricin, were considerably more efficacious than sulfathiazole, a widely used representative of the sulfonamides. As a matter of fact, 100 mg. of sulfathiazole applied to the infected wound failed to reduce the number of hemolytic streptococci in fifteen out of sixteen experiments, whereas 1 mg. of streptothricin and tyrothricin caused such a reduction in nine out of fourteen tests. Hence, these anti-biotics proved to be at least 100 times more effective than sulfathiazole. Penicillin, too, exerted considerably greater activity than sulfathiazole under these experimental conditions.

The question may be raised as to whether or not the ineffectiveness of sulfathiazole is due to the fact that treatment was carried out for a period of twenty-four hours only. However, previous experiments revealed that therapy with sulfonamides for forty-eight hours yielded only slightly better results.

Mention must be made of the fact that sulfathiazole, tyrothricin and streptothricin were applied to the wound as powder. Their therapeutic activity depends not only upon their specific anti-streptococcal efficacy, but also upon the degree and rate of dissolution in body fluids, their penetra-

tion into the infected tissues, their excretion and possible destruction in the wound itself.

As far as the failure of sulfathiazole to eradicate the hemolytic streptococcus is concerned, the observations reported here confirm previous findings with sulfanilamide.<sup>12,14</sup> It is interesting to note that according to Waud<sup>15</sup> the concentration of sulfathiazole applied locally was found to be much less in the tissues beyond 2 to 3 mm. below the surface of the wound than that ordinarily reached when sulfathiazole is given by mouth. It is desirable to reconsider the indications for the local implantation of sulfonamides in infections of man. From the study reported here it is evident that all anti-biotics tested, namely, penicillin, tyrothricin and streptothricin, proved to be more efficacious than sulfathiazole against the group A beta hemolytic streptococcus in artificial wounds of rabbits.

The toxicity of these agents differs to a considerable extent. Penicillin is considered to be almost non-toxic to human beings. Tyrothricin, on the other hand, has certain toxic properties which restrict its use to local application. Streptothricin, according to Waksman,<sup>8</sup> is characterized by limited toxicity to animals. Further investigations are necessary to determine whether or not this compound produces toxic effects when used therapeutically in human beings.

The spectra of activity of various anti-biotics show marked differences. Penicillin exerts definite anti-bacterial activity toward pneumococcus, streptococcus, staphylococcus, certain Gram-negative cocci (meningococcus and gonococcus), certain Clostridia and several others, but is largely ineffective against the majority of Gram-negative bacilli, including members of the Hemophilus group and the majority of enteric pathogens such as typhoid, paratyphoid and dysentery bacilli. Streptothricin, on the other hand, acts on various Gram-positive and Gram-negative bacteria. It is of particular significance that this compound proved to be effective in animal

experiments in certain paratyphoid and brucella infections. Tyrothricin, a mixture of gramicidin and tyrocidin, exerts its main antimicrobial activity against Gram-positive pathogens.

Of great importance is the stability or the instability of these compounds under conditions of infections. It is well known that penicillin may be rapidly destroyed by certain micro-organisms. Similarly, certain substances found in some Gram-negative micro-organisms are strongly inhibitory to tyrothricin. In contrast, streptothricin, according to Waksman,<sup>8</sup> is stable against destruction by various bacteria tested thus far.

It is evident from the data reviewed here that any of the anti-biotic substances have their limitations and that only by appropriate consideration of the infectious disease and the micro-organisms present as well as of the properties of the various anti-biotics will it be possible to select the best compound for treatment in individual instances. As far as hemolytic streptococcal infections in artificial wounds of rabbits are concerned, it is clear from the observations presented in this report that the anti-biotics penicillin, tyrothricin and streptothricin, are definitely superior to sulfathiazole. Further investigations are necessary to determine the relative efficacy of these compounds against other micro-organisms and to elucidate the question as to whether or not the simultaneous administration of two of these compounds may yield better results.

#### SUMMARY

1. In artificial wounds of rabbits infected with a strain of group A beta hemolytic streptococcus (susceptible *in vitro* to the action of all anti-microbial agents tested), streptothricin, tyrothricin and penicillin proved to be efficacious in decreasing the number of streptococci.

2. Tyrothricin and streptothricin were more effective than 100 times the amount of sulfathiazole.

3. No significant differences in activity

were noted between equal amounts of streptothricin and tyrothricin.

4. Penicillin in amounts of 2.5 to 5 units was ineffective; in larger amounts, ranging from 50 to 5,000 units, this drug reduced the number of hemolytic streptococci in the wounds.

5. The merits and limitations of the various compounds for the treatment of localized infections are discussed.

#### REFERENCES

1. FLOREY, M. E. and FLOREY, H. W. General and local administration of penicillin. *Lancet*, 1: 387, 1943.
2. SOPHIAN, L. H. The use of penicillin in topical application. *Am. J. Med. Sc.*, 208: 577, 1944.
3. PECK, F. B. Penicillin with special reference to its use in infections complicating diabetes. *Am. J. Med. Sc.*, 208: 581, 1944.
4. RAMMELKAMP, C. H. Use of tyrothricin in the treatment of infections. *War Med.*, 2: 830, 1942.
5. HERRELL, W. E. and BROWN, A. E. Chemotherapy in the treatment of streptococcal infections. *Minnesota Med.*, 24: 1059, 1941.
6. BRYAN, C. S., WELDY, M. L. and GREENBERG, J. The results obtained with tyrothricin in the treatment of 157 cows with streptococcic mastitis. *Vet. Med.*, 37: 364, 1942.
7. BEAN, C. W., MILLER, W. T. and HEISHMAN, J. O. Chemotherapy in mastitis. *Vet. Med.*, 37: 401, 1942.
8. WAKSMAN, S. A., BUGIE, E. and SCHATZ, A. Isolation of anti-biotic substances from soil micro-organisms, with special reference to streptothricin and streptomycin. *Proc. Staff Meet., Mayo Clin.*, 19: 537, 1944.
9. ROBINSON, H. J. Some toxicological, bacteriological and pharmacological properties of antimicrobial agents produced by soil micro-organisms. Thesis Rutgers University, 46 pp., 1943.
10. ROBINSON, H. J., GRAESSLE, O. E. and SMITH, D. G. Studies on the toxicity and activity of streptothricin. *Science*, 99: 540, 1944.
11. METZGER, H. J., WAKSMAN, S. A. and PUGH, L. H. *In vivo* activity of streptothricin against *Brucella abortus*. *Proc. Soc. Exper. Biol. & Med.*, 51: 251, 1942.
12. NETER, E., HUBBARD, R. and LAMBERTI, T. G. Effects of sulfanilamide and azochloramid upon hemolytic streptococci and staphylococci in wounds of rabbits. *Am. J. Surg.*, 65: 226, 1944.
13. SKELTON, S. M. The combined bacteriostatic activity of sulfanilamide and azochloramid upon streptococci *in vitro* and *in vivo* studies. *J. Bact.*, 47: 273, 1944.
14. LAMBERTI, T. G., HUBBARD, R. S. and NETER, E. Effects of sulfonamides and azochloramid on hemolytic streptococci in artificial wounds of rabbits. *J. Bact.*, 48: 612, 1944.
15. WAUD, R. A. The absorption of sulfathiazole from wounds. *Canad. M. A. J.*, 51: 229, 1944.

# USE AND ABUSE OF CESAREAN SECTION\*

EDWARD G. WATERS, M.D.

Assistant Clinical Professor of Obstetrics and Gynecology, Columbia University School of Medicine

NEW YORK, NEW YORK

NO obstetrician will deny that a suprapubic vagina would have solved his greatest headaches. Surely it seems that nature provided in man a most difficult manner of birth, a paradoxical reward for submitting to the profound biologic urge upon which continuity of the race depends. For parturition is complicated by a birth tract not only bony-walled and curved, but subjected to compromising variations in size and shape. And were this not enough, there are added variants in the adaptation of organs and tissues to the passage of a fetus which itself is no fixed factor.

The first labor is the crucial one for most, since it tests the pelvic capacity as well as the effectiveness of expulsive efforts upon the infant. True it is that hazards exist for subsequent parturitions, but a patient once successfully delivered at term of a normal infant never again presents the same problem. This equanimity of judgment is not always valid, nevertheless it exists. It is a tribute to the fact that the majority of dangers at the time of childbirth are dependent upon fetopelvic relationship and the successful continuity of the numerous physiologic changes which we encompass in the word "labor."

Countless generations attest that most babies successfully negotiate the normal birth tract. There exists a small percentage in which vaginal delivery is either impossible, or so compromises the safety of one of the principles involved that some other means must be taken to terminate the pregnancy or labor. It is with this small percentage, certainly seldom more

than five, that the subject of this presentation is concerned.

Cesarean section represents the *alternate* birth tract. Let no one ever believe it is the *best*. In its most successful application it carries a maternal death rate far higher than that noted in statistical compilations of vaginal deliveries. In less competent hands or under less favorable circumstances, the mortality may reach unbelievable figures. Yet when the indication is just and the performance is good, the procedure of cesarean section embodies a far better prospect for the principals than vaginal delivery.

The good use of cesarean section is, therefore, predicated upon careful case selection, since a bad choice of abdominal delivery might not be equalized by a technically satisfactory operation. And if its indications can be detailed with reasonable accuracy and adhered to, with good performance good results may be anticipated. Conversely, misuse of the operation eventually leads to needless disaster.

The *incidence of cesarean section* in most good clinics is not more than 5 per cent. It is conceivable that for small series such a figure may be exceeded or even a very low one achieved. Our own incidence for cesarean section in 68,786 deliveries was 2.67 per cent (1 in 1837 cases). It is fair to warn that an extremely low figure might be achieved and look good if one forgets subsequent repair of birth tract wreckage, or the mentally disabled or dead infants. For consideration of the results of ill-advised operative vaginal delivery is pertinent in any discussion of cesarean section.

\* From the Margaret Hague Maternity Hospital, Jersey City, N. J. Presented at the Chicago Medical Society Annual Clinical Conference March 14, 1944.

Thus a very low incidence may be too low when the end results of certain vaginal deliveries are seen. But an extremely high percentage of sections in a comprehensive series may indicate a careless handling of material, a casual interest in delivery probabilities or a disregard of recognized obstetric data and procedure.

The most common indication for cesarean section is cephalopelvic disproportion or maladjustment. Careful abdominopelvic examination, clinical and x-ray mensuration, and Hillis maneuver at term, generally serve to make those cases of actual disproportion obvious, with early resort to elective section. It is the borderline case which poses the question, often unanswerable until time for elective operation has long since passed. Most misleading is the patient who presents a markedly moulded head often to or below the spines but with non-engagement, in a pelvis of moderately restricted capacity. To section such patients indiscriminately would mean many needless operations, for with time and labor a large proportion deliver. Only the fine art of discrimination based upon years of experience, often bitter, suffices to make the proper decision. For labor efficiency, rapidity of cervical dilatation and effacement, mouldability of fetal head and soft tissue accommodation are factors of importance, immeasurable by any methods we now possess. It is in this type of borderline case that deflection attitudes in the fetus further complicate the delivery problem, and if unrecognized, lead either to a badly traumatizing and dangerous vaginal delivery, or a cesarean section in an infected patient. Rupture of the membranes prior to onset of labor and sluggish intermittent pains are other occurrences which deny these patients elective section. They are properly serviced only by application of extraperitoneal cesarean technics. "Cervical dystocia" with intermittent labor falls into the same group. Our clinic so frequently recognized the fallibility of experienced judgment that the chiefs of service commonly utilize

reciprocal consultation before deciding to operate. The incidence of cesarean section for dystocia problems in private cases has been materially reduced by requiring approved consultation in prolonged labor or dystocia cases before operation is considered. It is a safety stratagem which I strongly commend to you for protection of patient, doctor and hospital, one which might well be invoked in all cases everywhere. We have found it of value not only in avoiding needless sections but also in applying the proper abdominal operation when an otherwise sacrificial vaginal delivery had been contemplated.

A full term breech presentation in a primipara is not *per se* an indication for cesarean section. An unengaged breech after adequate pains for several hours may be. Here again the exercise of judgment must balance the hazards to maternal soft parts and fetus of vaginal delivery against a major abdominal operation. In our experience, the incidence of section for breech presentation in primiparae is not much higher than general cesarean section incidence. Other factors rather than the circumstance of breech presentation and adjustment more commonly influence the decision for section. No hard and fast rule can be made for transverse or compound presentations. These commonly occur with small babies or multiple pregnancies and set forth no problem. But a large fetus in neglected labor fixed in transposition may offer no choice other than vaginal operation with risk of uterine rupture or extraperitoneal cesarean section. Because of lower maternal mortality and morbidity and better fetal salvage, the latter procedure is the one of choice.

The three major hemorrhagic complications of the last trimester of pregnancy, abruption of the placenta, placenta previa and rupture of the uterus, produce many cesarean operations. How shall we proceed when faced with these emergencies?

It is fruitless to deny that many premature placental separations in multipara can be managed best by so-called conserv-



ative treatment, with vaginal delivery awaited. A placental abruption in any patient, especially primipara, with active bleeding, exhibition of shock and closed cervix, is best treated by cesarean section, after suitable measures are taken to combat shock and blood loss. In the mild type of abruption almost any form of treatment will give passable results. But our figures for so-called conservative treatment of severe abruption have not been any better than those achieved elsewhere, while the results with cesarean section suitably shielded by active anti-shock therapy are comparatively excellent. The figures I am submitting in the table on placental abruption testify to its worth.

Placenta previa can cause death from hemorrhage more quickly than almost any other condition, although the factor of shock is less notable than in abruption of the placenta. We believe cesarean section is a safer and better way to deliver women with placenta previa than any type of vaginal interference, such as bagging or Braxton-Hicks version. An exception is made in patients who bleed from partial previas only after considerable cervical dilatation is attained, especially in multipara. Here rupture of membranes and presenting part tamponade of the placenta may effectively check the bleeding and permit vaginal delivery. But dilatory management of a bleeding placenta previa with non-dilated cervix, notably primipara with no previous labor experience, denies the patient a decent chance to survive.

Rupture of the uterus obviously requires abdominal section as soon as the diagnosis is made and the patient made operable. The intraligamentous rupture with extraperitoneal bleeding can be diagnosed by vaginal palpation and an extraperitoneal approach made, thereby avoiding peritoneal contamination which so frequently ends with the patient's death. Hysterectomy in this type is unnecessary. With all other forms of rupture, cesarean-hysterectomy must be done and sulfa drugs with

other supporting therapy relied upon to check peritonitis.

The toxemias of pregnancy are not indications for cesarean section. Eclampsia almost never is. Antepartum eclampsia when brought under control may be followed by a cesarean if severe toxemia persists or recurs. In primipara, severe preeclampsia not responding to active treatment justifies section. In general, conservative management is applied in patients responding to antitoxic therapy, with section used only when progression of symptoms, especially in primipara, or other associated indications are manifest. Of 1,015 cases of pre-eclampsia in the past four years, thirty-three or 3.2 per cent were subjected to cesarean section. The incidence of toxemia in our clinic has steadily dropped in the past few years, reaching 3 per cent in 1943. It is obvious, therefore, that relatively few of our sections are solely for toxemia of pregnancy.

Since we regard classical section as largely of historic interest and as dubiously justifiable in this age as a blind trochar-ovariotomy, I wish to clarify our position with respect to repeat section. Since our operations, both trans- and extraperitoneal, are all low segment operations, we do not believe that repeat sections are invariably necessary. A large number will be, since disproportion is the most usual initial indication. But when the baby is much smaller, or the first section done for some non-recurrent reason such as placenta previa or toxemia, we permit labor and vaginal delivery in a considerable number. Low vertical incisions are not as safe as transverse, and are regarded with more suspicion. Classical incisions done elsewhere have caused uterine ruptures so often that we never voluntarily allow these patients to labor. The mortality from uterine rupture is so high that elective section should be routinely chosen in such patients previously operated upon in the manner of 1890 to 1920.

Cesarean section is indicated for certain abnormalities, such as bicornuate uterus

and vaginal stenosis, and such pathologic complications as carcinoma of the cervix, obstructing fibroids and pelvic incarceration of ovarian tumors. It may be elected, though not necessary, to save the pelvic structures from repeated trauma after such operations as cervical amputation, Manchester-Fothergill and other vaginal plastics. Careful consideration of existing conditions and competent consultation serve best the patient's need, since each case poses an individual problem. Pooling of experience in the uncommon situation is more imperative than elsewhere, since few possess the background of experience with rarely encountered conditions to give substance to expressed opinion.

There is appreciable fetal salvage from cesarean section when the cord prolapses through a non-dilated cervix following early rupture of membranes. This is especially true with primiparae. The circulation in the cord must be strong and maintained to justify the operation. Reposition attempts may succeed in other circumstances, or certain conditions may warrant conservative treatment with accepted risk of fetal loss. When the patient is elderly, primiparous or the social value of the child high, operation should be done promptly if reposition cannot be maintained.

In the presence of fetal malformation, no operation is justifiable except in the interest of the mother. Embryotomy, craniotomy, or cranial trypsis after adequate dilation is effected, are better procedures.

Elderly primipara are not to be assigned routinely to the operative list. Most of these patients beyond thirty-five years do as well in labor as the younger patients. However, they are in the last third of their childbearing years and in common with mankind in general have lived long enough to develop their share of hypertension, nephritis, cardiac lesions, diabetes, and other systemic and degenerative diseases. Since the childbearing years for them are few, the fetus develops a social

value not obtainable in earlier years. Therefore, while from a purely obstetric standpoint the elderly primipara poses a cephalopelvic problem of little greater moment, conditioning factors make cesarean section a more frequent consequence.

We do not utilize cesarean section in many cardiac patients. Major consideration is given antepartum cardiac care and normal delivery anticipated unless there are other complicating factors. Our experience with delivery problems in more than 600 cardiacs justifies this opinion. A difficult, prolonged or infected labor is to be avoided in cardiac patients who have ever decompensated or threaten to do so. There is a place for section in cardiac patients but it is infrequently needed and never without competent consultation. It is not justified solely for purposes of sterilization. Postpartum sterilization is an operation so simply and easily done that cesarean section is never required to replace it.

What of patients who have had unsuccessful attempts at vaginal delivery, or who have fallen into the group with potential or actual intrauterine infection? We cannot forestall rupture of membranes hours or days before onset of labor, prolonged but ineffectual labor in borderline cases, "cervical dystocia" with days of pseudolabor and amnionitis, prolapse of foot early in labor in a borderline pelvis, and numberless other encountered conditions. We must often operate upon patients who have been examined originally many times or under careless conditions or where the anticipated vaginal delivery does not transpire in the borderline pelvis. Wrong judgment and the passage of time place these patients in the potentially infected group. Here an extraperitoneal cesarean section offers the best solution. Many will do well with transperitoneal or exclusion types of cervical segment operation, plus sulfa therapy. For all others, the choice is between the Porro operation or the extraperitoneal cesarean. We have no especial quarrel with the Porro operation if one

cannot do better. It is a sacrificial operation which carries in many expert hands a high mortality. We prefer the extraperitoneal operation and with good reason. Two hundred fifty extraperitoneal cesarean operations, with only two maternal deaths, done in our clinic in the manner proposed by the author, with uterus and function of childbearing conserved, are exhibited that you may place your own value on the operation for the indications we choose. The indication for the use of this type of extraperitoneal cesarean operation, therefore, is infection either potential or actual. In these worst of risks, over a period of ten years, with extraperitoneal operations performed upon 431 patients, there were five deaths; an uncorrected maternal mortality of 1.16 per cent. In 1,261 low segment operations in the same period, only on generally good risk patients, the mor-

talidity was thirteen or 1.03 per cent. The argument that retention of the infected uterus is dangerous and unwise is denied by factual experience, and not by biased, unconsidered, inadequate nor inexperienced opinion. The factor of peritoneal contamination is the all important one in determining whether or not the patient will recover. All other considerations are relatively unimportant.

And in conclusion, let us remember that no cesarean operation will serve the patient well unless preoperative care is well considered and administered. Proper food and fluid balance, chemotherapy, both prophylactic in the interest of baby as well as mother and therapeutic when indicated, hemotherapy, intravenous administration of amino acids in vomiting and starvation, and other supportive measures are imperative if one is to obtain consistently good results.



# FRACTURES OF THE ACETABULUM\*

W. RUSSELL MACAUSLAND, M.D. AND  
Surgeon-in-Chief, Orthopedic Department, Carney  
Hospital

HAROLD G. LEE, M.D.  
Orthopedic Surgeon, Carney Hospital

BOSTON, MASSACHUSETTS

AMONG the varieties of fractures of the acetabulum that present problems in treatment, and which from out the fact that the prognosis in such injuries must be guarded, regardless of the accuracy of reduction and the care taken



FIG. 1. Case 1. L. H. Roentgenogram taken one week after manipulation and traction, showing the acetabular fragment still displaced and the femoral head incompletely reduced.

a prognostic standpoint are of special interest are: (1) Fracture of the upper and posterior rim of the acetabulum associated with dislocation of the femoral head and displacement of a fragment, and (2) comminuted fractures of the acetabular floor with intrapelvic penetration of the femoral head.

In the following case reports, illustrative methods of handling these types of fractures are presented. Late evaluation of the end results in these cases clearly brought

to protect the joint from weight-bearing until consolidation is complete.

## CASE REPORTS

CASE 1. L. H., a man forty-two years of age, was injured in a railroad accident on December 24, 1943, sustaining a posterior dislocation of the right hip which was complicated by a fracture of the upper and posterior rim of the acetabulum. A roentgenogram taken at the time of the injury showed the femoral head dislocated upward and backward, and the upper posterior rim of the acetabulum torn

\* From the MacAusland Orthopedic Clinic.

away and displaced in the same direction as the femoral head. An attempt was made by a local surgeon to reduce the dislocation by

crest. A subperiosteal dissection was carried out, exposing the fracture. The blood clots were removed. The dislocated femoral head was



FIG. 2. Case 1. L. H. Acetabular fragment fixed in place with a screw.

manipulation and the use of longitudinal skeletal traction, which was established by introducing a pin in the lower femur and applying forty pounds of weight. After twenty-four hours, the weight was reduced to thirty pounds, and later to fifteen pounds. Although the reduction of the hip was maintained by this means, the displaced fragment was not affected and upon the release of the traction, the femoral head again dislocated. (Fig. 1.)

Operative treatment was as follows: On January 5, 1944, the patient was placed prone on the operating table, with the right hip slightly elevated. General anesthesia was used.

The upper posterior rim of the acetabulum was approached by an incision that started just below the anterior superior spine, and following the line of the iliac crest, extended to the posterior superior spine. The incision was carried down through the periosteum of the

readily reduced. The lip fragment was replaced and fixed in position with a screw. (Fig. 2.)

The gluteal flap was replaced, and the periosteum sutured along the iliac crest. The skin was closed with interrupted sutures. A tightly fitted flannel spica was applied to provide compression.

Traction was established by means of a Steinmann pin, which had been placed in the lower femur prior to the surgical interference, and the application of ten pounds of weight, the object of this traction being to prevent the femoral head from pressing against the replaced acetabular fragment. This traction was maintained for a period of six weeks. During this time, roentgenograms were taken at regular intervals to check the position of the femoral head and the acetabular fragment.

Because of the complications of phlebitis and an embolus to the lung, this patient remained

in bed for three weeks after the traction had been removed. No motion at the hip was permitted during the entire two months that the patient remained in bed.

On March 8, 1944, the patient began to walk with the aid of crutches, and was encouraged to practice muscle contractions. At the end of March, he was touching the toe of the injured extremity to the floor.

By May, 1944, the motion at the hip was normal. The patient was walking well with the aid of a cane. On August 9, 1944, when the patient was last examined, he was walking well without support; there was no limp and the motion at the hip was normal. A roentgenogram showed the fragment in excellent position. (Fig. 3.) Although up to this writing, the functional recovery has been excellent, it is too early to determine the final outcome, in view of the possibility of the later development of degenerative changes following such injuries.

CASE II. E. B., a male nineteen years of age, was injured in an automobile accident on January 31, 1942, sustaining a fracture of the upper acetabular rim associated with a posterior dislocation of the femoral head. (Fig. 4.)

poor condition of the patient, interference had to be postponed for a week.

At operation a straight incision was made

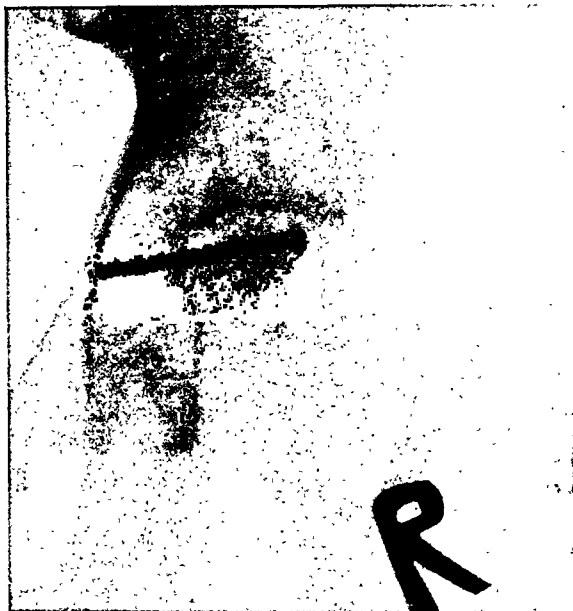


FIG. 3. Case I. L. H. Roentgenogram taken seven months after fixation of the acetabular fragment.



FIG. 4. Case II. E. B. Roentgenogram showing posterior dislocation of the hip with displacement of a large fragment of the acetabular rim.



FIG. 5. Case II. E. B. Postoperative roentgenogram showing perfect position four days after reduction of the dislocation and fixation of the acetabular fragment.

Because of the size of the fragment, operative reduction was advised, but on account of the

posterior to the greater trochanter, in the line of the femur. The muscles were separated,

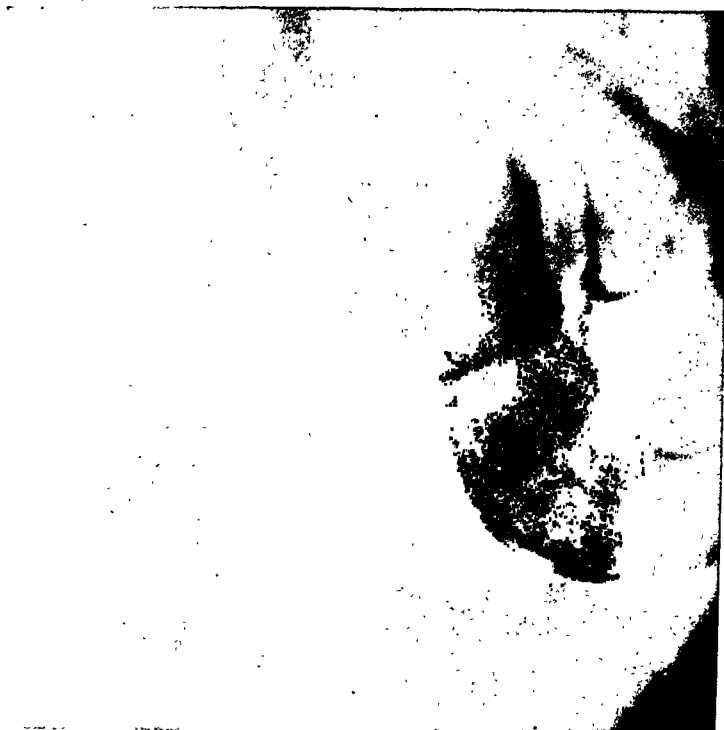


FIG. 6. Case III. J. S. Roentgenogram taken following manipulation, showing acetabular fragment still displaced.



FIG. 7. Case III. J. S. Postoperative roentgenogram taken two years after reduction, showing mottling, necrosis, and flattening of the femoral head.



FIG. 8. Case III. J. S. Postoperative roentgenogram taken nearly six years after reduction, showing mottled density of the femoral head with distortion, and increased density of the entire acetabulum.

exposing the fracture. The dislocated femoral head was readily reduced, and the fragment replaced and fixed in position with a screw,

large fragment was broken off from the upper posterior rim of the acetabulum, and displaced. On the same day as the injury, when the patient



FIG. 9. Case iv. E. G. Fracture of the acetabular floor with intrapelvic penetration of the femoral head.

which was directed upward and backward. (Figl 5.) The wound was closed. A plaster spica extending from the rib line to the ankle was applied, with the extremity in the position of slight eversion and abduction of twenty-five degrees.

Within two weeks the patient was walking with the aid of crutches. Eight weeks after the operation, the lower part of the plaster cast from the knee down was removed, and three months from the time of the injury, the remainder of the cast was removed. At that time weight-bearing was resumed.

This patient has perfect function of the hip at the present time (October 1944), and for two years he has been in the Air Force in Europe.

CASE III. J. S., a man forty-five years of age, on March 26, 1938, was thrown from a wagon, and one of the wheels ran over him. His right hip was dislocated posteriorly, and a

had recovered sufficiently from shock, an attempt was made to reduce the fracture dislocation by manipulation. The broken acetabular segment failed to fall into place. (Fig. 6.)

At operation on April 1, 1938, reduction and fixation of the fragment were carried out according to the technic that has been described under Case II, except that a bone screw was used to anchor the fragment. Weight-bearing was begun in three months after the operation.

The hip recovered good function, there being only a slight limitation of motion in abduction and rotation. However, a roentgenogram taken in March, 1940, two years after the injury, showed evidence of mottling, necrosis, and flattening of the femoral head. (Fig. 7.) Another check roentgenogram taken on February 18, 1944, nearly six years after the injury, showed a mottled density of the femoral head with a small amount of distortion, and



increased density of the entire acetabulum. There was also partial destruction of the joint consistent with degenerative arthritis. (Fig.

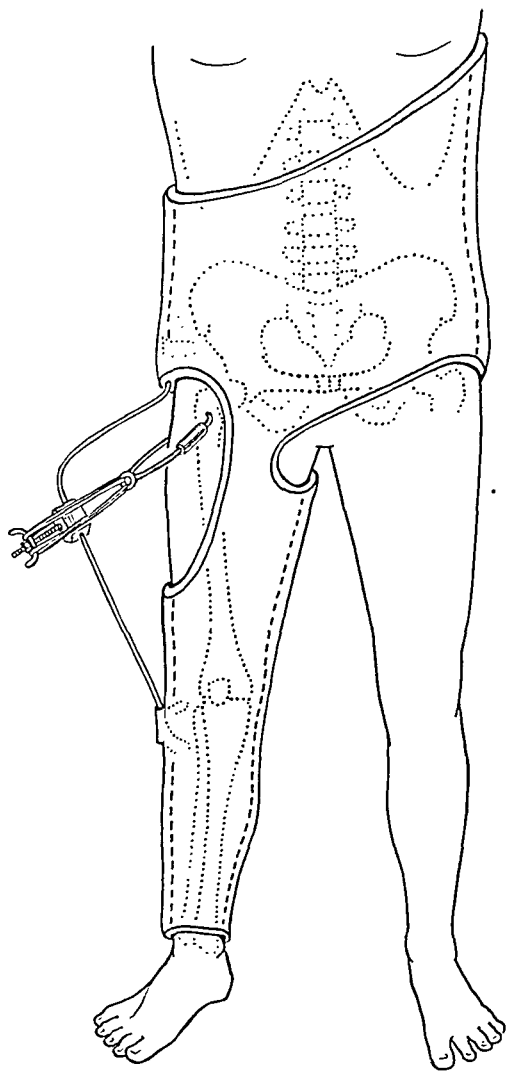


FIG. 10. Case IV. E. G. An outrigger equipment to provide for lateral traction.

8.) At that time, the hip had complete flexion movement, approximately thirty-five degrees of rotation, and abduction of twenty-five degrees.

#### COMMENT

In two of the cases that have been reported, surgical replacement of the acetabular fragment was carried out when the fragment failed to fall into normal position upon manipulative reduction of the dislocated femoral head. In the third case

operative indications were recognized immediately. Surgical fixation is practically always indicated in fractures at a dependent point of the acetabular rim, and in addition to ensuring anatomical replacement, fixation has the advantage of shortening the convalescence and of promoting early union.

CASE III illustrates the development of necrosis of the femoral head after a period of apparent recovery. Two years after operative fixation, abnormal changes had appeared in the femoral head, and six years after the injury, there was extensive destruction of the hip joint. The significance from an industrial standpoint of such delayed degeneration of the femoral head, which produces an arthritic hip with limited and painful motion, is manifest.

CASE IV. E. G., a man fifty-three years of age, on January 18, 1942, received a fracture of the acetabulum in an automobile accident. Following the injury he was in severe shock, and the abdomen was distended slightly. Roentgenographic examination of the hip showed the floor of the acetabulum driven inward in one piece. (Fig. 9.) Two days after the fracture, when the patient had recovered from shock, reduction was carried out as follows:

With the patient under spinal anesthesia, a Kirschner wire was inserted through the base of the greater trochanter at a right angle to the shaft of the femur. A plaster spica with a long outrigger equipment incorporated was applied to the pelvis and the injured extremity. (Fig. 10.) An opening was made in the cast of sufficient size to allow for the correction of deformity, visualization, and adjustment. Traction in the line of the femoral neck was established by means of elastic bands. (An attempt to palpate the fragments through the rectum was only moderately satisfactory.) Roentgenographic examination following the application of the traction showed that the femoral head had been pulled out and was in good position. (Fig. 11.)

Six weeks after the reduction, the plaster spica was removed, and the patient began to walk with the aid of crutches. Active motion at the hip was started, but no weight-bearing was permitted. At the end of three months from the time of the injury, the patient began to bear weight. Throughout the convalescence,

roentgenograms were taken to check the position.

One year after the injury, roentgenograms

This patient had been treated by establishing lateral traction. Although this is the generally recognized treatment of



FIG. 11. Case iv. E. G. Roentgenogram showing the femoral head pulled out of the cotyloid cavity by lateral traction.

showed a well healed and reconstituted acetabular floor, and a good joint space. Clinically, there was slight limitation in external rotation and abduction; other motions were free. The patient had no limp. Further roentgenograms were taken in October, 1944, two and a half years after the injury. At that time the joint space was narrowed, there were proliferative changes about the femoral head and acetabulum, and there was some distortion of the acetabulum. (Fig. 12.) Clinically, abduction and rotary motions were definitely limited.

#### COMMENT

Case iv illustrates again the development of late destructive changes in the hip joint. Whereas one year after the injury, there was a good joint space and a well constructed acetabular floor, one and a half years later, roentgenograms showed marked destructive changes in the joint. Motions at the joint were markedly decreased.

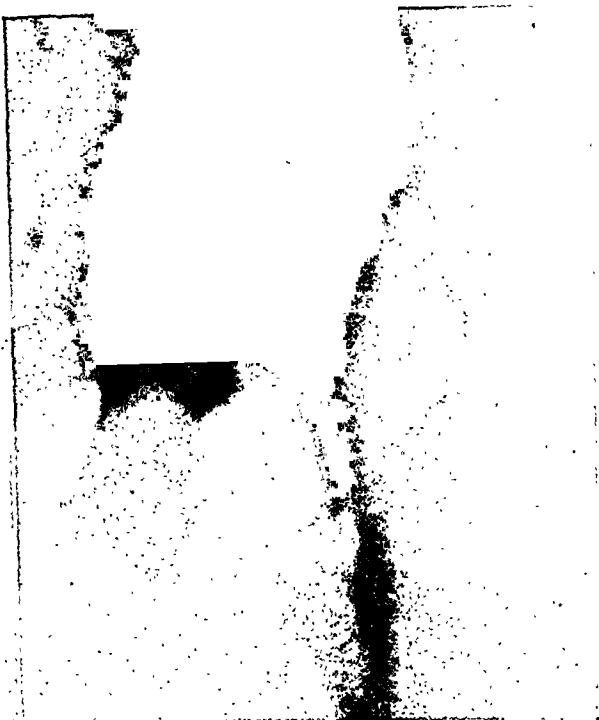


FIG. 12. Case iv. E. G. Roentgenogram taken two and one-half years after reduction by traction, showing a narrowed joint space, with proliferative changes about the femoral head and acetabulum, and some distortion of the acetabulum.

intrapelvic dislocations of the femoral head, when the capsular attachments of the acetabular fragments are torn, few methods of obtaining such lateral traction have been suggested. For the most part, attempts to provide lateral traction by means of adhesive tape on the thigh, with weights attached, have been abandoned. Methods of obtaining more direct traction by means of introducing a Steinmann pin, nail, or screw in the trochanteric region, and establishing a continuous pull, have been suggested by Putti, Leveuf, Fitte, and Moore.

Putti's method consists of introducing a nail vertically through the greater trochanter by two incisions, one for its entrance and one for its exit. Both ends of the nail protrude, and to them is attached elastic that is fixed to a metallic arch

incorporated in a femoral-pelvic cast. Traction is exerted manually in both directions before the plaster cast is applied.

In Leveuf's method, a long nail is introduced into the lower part of the femoral neck, and a plaster cast is applied extending to the knee, with a window cut out over the trochanteric region. Reduction is obtained by means of a special metallic apparatus that is incorporated in the plaster cast and attached to the nail. It is Leveuf's opinion that in extreme displacements of the femoral head, it is more efficient to introduce the nail into the femoral neck than into the greater trochanter. Leveuf later used a screw in place of the nail, which is less likely to slip before consolidation is complete. Successful use of this method has been reported by Rigal, who added a weight to the regular metallic apparatus, in order to obtain longitudinal reduction.

#### SUMMARY

Three cases of fracture of the acetabular rim associated with a posterior dislocation of the hip have been presented. Surgical replacement of the acetabular fragment has been described.

One case of fracture of the floor of the acetabulum associated with intrapelvic

dislocation of the femoral head has been presented. A method of obtaining lateral traction by means of an outrigger incorporated in a plaster cast has been described.

Late examination in one case of fracture of the acetabular rim and in the case of intrapelvic dislocation showed degenerative changes in the joint, confirming the general opinion that final results in these cases must not be evaluated until from two to three years after the injury. The prognosis would seem to be more favorable when anatomical reduction is carried out early, and when the patient is not permitted to bear weight until the fracture is well healed.

#### REFERENCES

- FITTE, M. La tracción esquelética con la tirabuzón en las fracturas del cotilo. *Bol. y trab. de la Soc. de cir. de Buenos Aires*, 22: 249, 1938.
- MOORE, J. R. Fractures of the upper end of the femur including fracture dislocations at the hip joint. *Am. J. Surg.*, 44: 117, 1939.
- LEVEUF, J. Fracture par enfoncement du cotyle avec pénétration intrapelvienne de la tête fémorale (deuxième observation). *Bull. et mém. Soc. nat. de chir.*, 58: 1537, 1932.
- LEVEUF, J. and PAKOWSKI. Fracture par enfoncement du cotyle avec pénétration intrapelvienne de la tête fémorale. *Ibid.*, p. 818.
- PUTTI, V. Sulla terapia della lussazione. *Cbir. d. org. di movimento*, 11: 530, 1927.
- RIGAL. Fracture de la cavité cotyloïde avec pénétration de la tête fémorale dans le bassin. *Lyon chir.*, 36: 320, 1939.



# PAGET'S DISEASE OF THE NIPPLE

JUSTUS KAUFMAN, M.D.

Assistant Clinical Professor in Surgery, New York Medical College, Flower and Fifth Avenue Hospitals  
NEW YORK, NEW YORK

THE relative rarity of Paget's disease of the nipple and the discrepancy of opinion as to its pathogenesis and management has prompted this critical review. Based upon personal observation, I believe that Paget's disease is not a precancerous lesion but is a malignancy from its very onset. Untreated or inadequately treated, Paget's disease is as invariably malignant as any other mammary carcinoma. While there probably is a natural temptation to be conservative in treating Paget's disease of the nipple when there are no clinical signs of underlying breast involvement, nevertheless, this attitude should be condemned.

Clinically, I have seen what appeared to be an innocuous lesion of the nipple (histologically Paget's disease) without any palpable masses in the breast, develop axillary metastases fourteen months after mastectomy and postoperative radiation. Likewise, I have seen histologically proven axillary metastasis from an isolated lesion in the nipple without gross involvement of the intervening breast tissue. However, the presence of a Paget's disease of the nipple and a concomitant underlying intramammary carcinoma is the more frequent observation in the neglected cases. Late cases show generalized metastasis.

An analysis of cases of this type coupled with a consideration of the pathogenesis of Paget's disease certainly favors radical mastectomy and axillary dissection as the treatment of choice. It is fortunate that the lesion is readily accessible so that biopsy may be performed and an early diagnosis obtained.

The first cognizance of a surface lesion of the nipple is attributed to Velpeau in 1840. The association of the lesion of the nipple with carcinoma of the breast was

not considered until 1874, when Paget described 15 cases of an eruption of the nipple, some of which were accompanied by an underlying carcinoma. The relationship of the surface lesion with the deep seated neoplasm has been a source of contention and various theories have been advanced by Cheattle,<sup>1</sup> by Bloodgood, by MacFarland<sup>2</sup> and by Muir.<sup>3</sup>

We feel that the most substantial theory is that of Keith Inglis.<sup>4</sup> His pathological studies show that Paget's disease is a malignant disease from its very onset. The lesion starts at the junction of the lactiferous duct with the epidermis or in a duct very close to its outlet. From this location, without the formation of any nodule, the malignant cells spread centrifugally and continuously within the confines of the surface epithelium. It permeates peripherally into the epidermis of the nipple and distally between the epithelial cells lining the duct walls down to the acini. Consequently, a cross section of the nipple may reveal two adjacent ducts, one involved by the neoplasm and the other free of disease.

Apparently in Paget's disease, the type of spread of malignancy is unique inasmuch as the extension is intra-epithelial. When first observed, there is no break through the subjacent connective tissue. A cross section of a duct would show a ring of neoplastic cells in the very substance of the epithelial lining. A three dimensional visualization would be a hollow cylinder of cells within the duct lining. In the more advanced stage, the malignant cells break through into the lumen of the duct so that cancer cells are observed intraluminary without any connective tissue stroma support. The ducts themselves do not undergo neoplastic proliferation; the lining epithelium is

merely being invaded. Contrast this with an intraductal carcinoma in which there is an out growth of neoplastic tissue from the duct wall in a more or less complex papillary arrangement with supporting axial strands of connective tissue. Likewise, contrast this with the neoplastic lesion that from its very onset extends beyond the basement membrane into the connective tissue.

The intra-epithelial neoplastic cell—the Paget cell—has a characteristic appearance. It represents a malignant epithelial cell growing in non-neoplastic epithelium, in ducts as well as in epidermis. The cells are large, have deeply staining nucleus and pale clear shrunken cytoplasm. The appearance of vacuolation is due to the formation of clefts between the Paget cells and the adjacent epithelial cells. Dr. R. J. Ludford, from cytological studies, believes that the Paget cell arises from the basal layers of the epidermis. He finds the active development of these cells in the rete Malpighi, while at a higher level they tend to become degenerated. There seems to be an inherent tendency for the Paget cells to undergo early degeneration and necrosis.

This degeneration accounts for the fact that groups of Paget cells may be separated by normal epithelium. In all probability, the intervening neoplastic tissue had degenerated. Clinically, this explains the appearance of fresh, isolated minute foci at the margin of the nipple. The tendency for degeneration and death of Paget cells is almost equal to the rate of proliferation, therefore, the advancing margin extends very slowly. Another factor in the slow course of the disease is that Paget cells are inhibited from exerting their full malignant properties by the restraining influence of the duct wall. The slow development of the disease is illustrated by Jamieson's case which remained dormant for twenty years and Darier's case which remained dormant for eleven years. In both instances, scirrhus carcinoma eventually developed.

If we adhere to the concept of Keith

Inglis, that the point of origin of Paget's disease is the duct-skin junction, then the peripheral infiltration will produce extensive undermining of the areolar epithelium with neoplastic cells. These cells will eventually break through the epidermis producing ulceration at several points with apparent normal intervening epithelium or skin. At a later time, this same process may extend downward into the duct system and a neoplastic mass may appear in the substance of the breast. Occasionally, the first evidence of extension is into the breast and the nipple involvement may appear subsequently as a delayed direct surface extension. In the duct lesion, the neoplastic cells fill the lumen; while in the skin lesion, the Paget cells are thrown off with the discharge. Fresh scrapings about the nipple, when properly prepared for histological study, may show malignant cells.

On rare occasions, Paget's disease has given rise to carcinoma in the connective tissue of the breast. The breakaway is never from the skin surface but rather from the duct or acini.

As a result of the intra-epithelial Paget cells, the skin about the nipple may at first be thrown into prominent folds. This thickening is augmented by the underlying inflammatory zone in the connective tissue. The presence of the neoplastic cells stimulates the inflammatory reaction which consists of a broad band of subepithelial lymphocytic and plasma cell infiltration. This inflammatory zone is one of the pathognomonic features of Paget's disease. It is inconspicuous around the ducts, being apparently limited to the subepithelial area and the area around the blood vessel.

The superficial portion of the epithelium may be thinned out and atrophic as a result of trophic and lymphatic disturbances. Consequently the neoplasm may extend directly through the skin and form a malignant ulcer.

The usual appearance of the nipple of Paget's disease is a reddish, dry lesion covered by fine scales. Later there is a

cracking and crusting with a discharge from the nipple which varies from clear to blood stained. When there is extension down an isolated duct or ducts, there is an associated inflammatory fibrous thickening in the adjacent tissue which can be palpated as a nodule. There may be a hard definite edge to the areolar. With a widespread involvement, one finds a diffuse thickening rather than an isolated nodule. After the disease has existed for several years, there is some obliteration of the ducts, with subsequent periductal fibrosis. This causes retraction of the nipple in the absence of infiltrating carcinoma. The patient usually seeks medical assistance when there is a bright red, raw looking nipple that has failed to respond to her own treatment.

In the differential diagnosis of Paget's disease, the following should be considered: eczema, syphilis infection (e.g., secondary to human bite), invasion of the nipple from carcinoma below and carcinoma of an epitheliomatous nature or from a sebaceous gland. In eczema, the lesion is soft, moist and pliable. In Paget's disease, the lesion is somewhat indurated. Generally speaking, lesions of the nipple are much too serious to depend entirely upon clinical diagnosis. All suspicious lesions of the nipple should be submitted for histological study. A specimen from the spreading margin, in the case of Paget's disease, will usually reveal the characteristic invading Paget cells. In eczema, there is an increased thickness of the epidermis with elongated interpapillary processes. There is considerable inflammatory reaction in the dermis. The characteristic findings of Paget's disease are absent.

In view of the nature of Paget's disease and its mode of dissemination, the futility

of local treatment to the nipple is obvious. While superficial radium or x-ray might cure the skin lesion, the underlying carcinoma of the ducts is unaffected. With a biopsy report of Paget's disease from an isolated nipple lesion, radical mastectomy is the procedure of choice. This was advocated by Bloodgood<sup>5</sup> in 1924. I wholeheartedly agree with his point of view.

#### SUMMARY

1. Paget's disease is a malignant disease from its onset even when there is only an isolated involvement of the nipple, the disease having the potentialities of any other malignant tumor. It starts at the junction of the lactiferous duct with the epidermis and spreads toward the skin and into the duct system. A deep seated scirrhous carcinoma is part and parcel of the same disease.

2. A specimen for biopsy should be obtained in all doubtful cases. The characteristic intra-epithelial Paget cells in the epidermis and in the ducts and the characteristic subepithelial inflammatory reaction are diagnostic.

3. Local treatment to the nipple is useless. Radical mastectomy offers the best opportunity for cure.

#### REFERENCES

1. CHEATLE, G. LENTHAL and CUTLER, M. Tumors of the Breast. London, 1931; CHEATLE, G. LENTHAL. *Surg., Gynec. & Obst.*, 66: 526, 1938.
2. THAYER, McFARLAND. The Breast. Anomalies, Diseases, Treatment. Oxford Univ. Press.
3. MUIR, ROBERT. Paget's disease, *J. Path. & Bact.*, 49: 299, 1939.
4. INGLIS, KEITH. Paget's Disease of the Nipple. London, 1936. Oxford Univ. Press.
5. BLOODGOOD, J. C. Paget's disease of the female nipple; a preventative disease, curable in its early stages, a study of 30 cases. *Arch. Surg.*, 8: 461, 1924.



# ASYMPTOMATIC PYURIA IN YOUNG MEN\*

LIEUT. FRANCIS A. BENEVENTI

MEDICAL CORPS, UNITED STATES NAVAL RESERVE

WHEN white blood cells exceeding what is considered a normal number are found in the urine, one

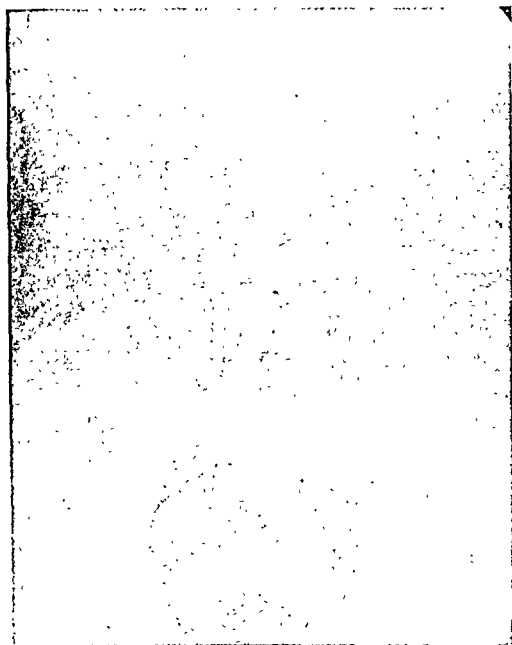


FIG. 1. Case 1. Double kidney on the left side with incomplete duplication of the ureter. Only one ureteral opening into the left side of the trigone.

they possess clear urines; but once in the service, when the frequency of physical examinations increases, either in the nature of annual physicals, or for promotions, or for change of tour of duty, the chances of discovering an abnormal urine specimen increase. Then the search for a pathological process along the urological tract is carried out.

In a moderately sized Naval mobile hospital unit in the tropics, fifteen men out of eighty who were given complete urological work-ups and who were considered good physical specimens, cast off showers of white blood cells in their urines at one time or another. The principal reason for their being referred to urology was the presence of white blood cells in their urines. Some were hospital patients in wards other than the urological and were turned over to us when routine urinalyses disclosed the presence of white blood cells. Others were detected during routine physical examinations for promotion or transfer. In five of these fifteen patients a serious upper urological tract condition was found. Three cases were anomalies of the kidney, one was a bilateral hydronephrosis, and the fifth was a large stone of the kidney pelvis with consequent hydronephrosis of that side. Of the remaining ten patients, two were found to have inflammatory strictures of the ureters, two had chronic prostatitis, and in six no disorder of the urological tract could be found. These six patients were discharged with the diagnosis of "no disease." All patients had showers of pus cells in their urines at one time or another. All were good physical specimens without apparent disability, and all were under

immediately sets out to look for a pathological condition in the urinary tract and usually finds it. In such patients, symptoms and signs referable to disease of the urological tract are present. However, there are young men with serious disorders of the urological tract who complain of no symptoms and who give as the only clue to the existing condition the presence of leucocytes in occasional specimens of urine. Not all specimens of urine taken from these young men will contain pus cells. It is readily apparent then that these men can enter naval and military services undetected because at the time of enlistment

\* The opinions or assertions contained herein are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Department or the Naval Service at large.

twenty-six years of age except the patient with stone who was thirty-seven.

Various authors have different standards

males only two to three leucocytes per low power field is normal, while Moore finds that the average leucocyte content

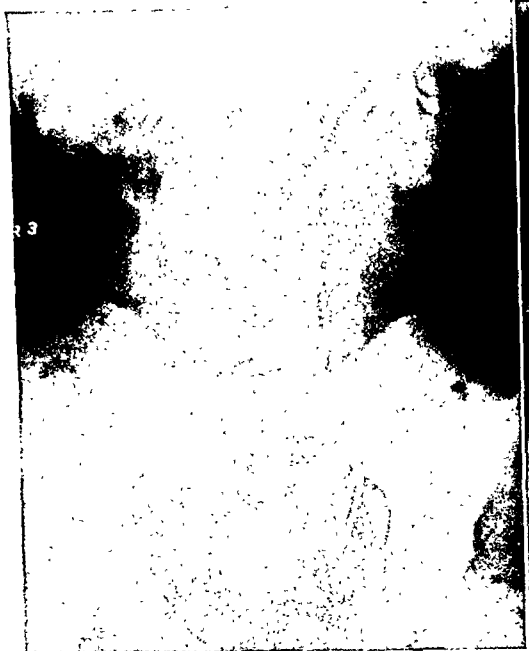


FIG. 2. Case II. Double kidney on the left side with complete duplication of the left ureter. Two ureteral openings in the left side of trigone.



FIG. 3. Case III. Crossed renal ectopia. Two kidneys on left side, none on the right. Left kidney rotated 180 degrees, right rotated 90 degrees.



FIG. 4. Case IV. Silent stone in right kidney pelvis serving as a ball-valve at the pelvic outlet.



FIG. 5. Case V. Symptomless bilateral hydronephrosis in a robust twenty-six year old male.

by which they judge normal urinary specimens on microscopic appearance.

For example, Helmholz believes that in

was always less than four per high power field in cases in which urinary diseases could be definitely excluded. However,



Eisendrath and Rolnick believe that five to seven white blood cells per high power field are still considered normal, while Hepler states that eight cells per high power field is still considered normal. All these findings have been recorded on centrifuged specimens of urine.

#### CASE REPORTS

**CASE I.** A twenty-six year old male was sent in because of occasional cloudy urine. He gave a history of having had an urethral discharge several months previously, which was always negative for gonococci. On admission here, a urinalysis showed a few white blood cells. He complained of no symptoms whatsoever, and there were no signs referable to the genitourinary tract. Cystoscopy and retrograde pyelograms revealed the presence of a double kidney on the left side with incomplete duplication of the ureter. (Fig. 1.)

There was only one ureteral opening on the left side of the trigone. Fusion of both left ureters took place about 8 cm. above the intramural portion of the bladder.

**CASE II.** A twenty-two year old boy who had never been ill a day in his life came into the hospital for a routine examination and urinalysis for transfer to the diving school. The centrifuged urine showed ten to fifteen white blood cells per high power field. The patient was an excellent physical specimen. Repeated urinalyses showed three to four white blood cells in the next three specimens. At cystoscopy, two ureteral orifices were seen at the left angle of the trigone and one opening on the right. A No. 6 French opaque catheter was easily placed in the left renal pelvis, and it was possible to pass only a No. 5 in the second opening on the left side for a distance of 7 cm.

Retrograde pyelograms showed a double kidney on the left side with complete duplication of the ureter on the same side. (Fig. 2.)

**CASE III.** A twenty-three year old boy was on the medical service complaining of generalized aches and pains. Several specimens of urine were loaded with white blood cells, and others had none. Retrograde pyelograms revealed the presence of two kidneys on the left side and none on the right. The left kidney was seen (Fig. 3) rotated 180 degrees with its laterally placed pelvis. The lower or ectopic

crossed kidney was seen rotated 90 degrees with marked dilatation of the pelvis. The right ureter crossed over to the left side at the level of the fifth lumbar vertebra. This was a case of crossed renal ectopia. Pus cells in abnormal quantities were recovered from both kidneys.

**CASE IV.** A thirty-seven year old male had been on the medical service with the complaint of arthritis. On admission, a specimen of his urine contained large quantities of leucocytes and repeated analyses of the urine were negative on several other occasions. He was referred to us to rule out a possible focus of infection in the urological tract.

Retrograde pyelogram (Fig. 4) showed the presence of a stone in the right kidney pelvis.

**CASE V.** A twenty-six year old male had urethral discharge three weeks before admission, which was always negative for gonococci and which responded to sulfadiazine therapy. On urinalysis two weeks later his medical officer was able to detect the presence of leucocytes in occasional specimens and he was referred to us for that sole reason. He had no symptoms whatsoever. Retrograde pyelograms (Fig. 5) revealed the presence of bilateral hydronephrosis.

#### SUMMARY

Eighty patients have had complete urological work-ups on this base in the last six months. Fifteen of these patients had no symptoms whatsoever, and they were given a complete urological work-up solely because of the presence of white blood cells in occasional specimens of urine. In five patients, a serious urological disorder was found. In only six of these fifteen asymptomatic cases, no pathological condition was found.

The importance of investigating any young man who has leucocytes in his urine whether persistent or sporadic in spite of the fact that he is without symptoms is stressed. Its significance is apparent from our small series of cases.

#### REFERENCES

1. EISENDRATH and ROLNICK. *Urology*, Philadelphia, 1938. J. B. Lippincott Co.
2. HELMHOLZ, H. F. *Lancet*, 50: 131, 1930.
3. HEPLER, A. B. and SCOTT, R. T. *J. A. M. A.*, 105: 499, 1935.
4. MOORE, THOMAS. *J. Urol.*, 49: 203, 1943.

# ETHYL ALCOHOL INTRAVENOUSLY AS POSTOPERATIVE SEDATIVE

R. J. BEHAN, M.D.

Surgeon, St. Joseph's Hospital  
PITTSBURGH, PENNSYLVANIA

A NUMBER of years ago, in 1920 to be exact, I became convinced that alcohol given intravenously could be beneficially used as a treatment for septicemia. The first patient with puerperal septicemia to be so treated was greatly benefited. Since this initial case I have on many occasions intravenously injected alcohol properly diluted for generalized infections with considerable success. During these treatments it was noted that quickly following the intravenous injection of alcohol, patients became quieter and usually entered upon a peaceful slumber. This suggested that alcohol given intravenously might with benefit be used as a narcotic, thus taking the place of morphine as a routine postoperative sedative.

Alcohol belongs to the group of cerebral depressants and lessens the sensitivity to pain. It affects first the cerebrum, then the cord, and last of all, the respiratory centers, while morphine depresses the respiratory centers simultaneously with the depression of the cerebrum and to a lesser extent, the reflex excitability of the cord.\* Thus alcohol should prove more effective as a postoperative sedative than morphine.

In thirty consecutive cases in which I have given alcohol intravenously, I have found it necessary only occasionally to bolster the effect of the alcohol with morphine to relieve pain. At times the injection produces a feeling of exhilaration. One patient was badly intoxicated by a single injection. In no patient did we notice any deleterious effect. In several instances we thought that the immediate post-operative course of the patient was easier, quieter, and less disturbed than was usual in cases

of similar operative type in which alcohol had not been used.

I have also given alcohol intravenously in proper dilution to insane and restless individuals with beneficial results. Quiet and sedation quickly followed its introduction.

The intravenous injection of alcohol has also proved to be of value in the treatment of alcoholics who, deprived of their usual stimulant, were in the restless and ungovernable period of delirium tremens. Because of vomiting from an irritated stomach, they could not take whiskey by mouth.

Alcohol intravenously was also used as a ready means of supplying energy to severely debilitated and weakened individuals and to those in sudden asthenic crises and shock. A good example was a marasmatic child who was unable to assimilate nourishment. Alcohol, plus amino-acetic acid in proper dilution in glucose, 5 per cent, and saline solution, was given intravenously. The child quickly recovered.

Intravenous alcohol was also found to be of value in diabetics who were in coma and required quickly utilizable energizing substances.

It was found that properly diluted alcohol used intravenously acted in a phenomenal manner in abolishing pain. It increased the peripheral circulation in patients with diabetic gangrene of the extremities and produced routine post-operative sedation and rest.

We have also given alcohol intravenously as a means of obtaining relaxing sleep in the excitable states so frequently present in paranoiacs.

\* MEYER, H. H. and GOTTLIEB, R. *Pharmacology*. P. 29. Philadelphia, 1914. J. B. Lippincott.

TABLE I

	Special Symptoms																							
	4	6	2	4	2	3	2	1	1	1	2	1	1	Synovectomy, knee	Pain			Sleep						
															Severe	Slight	None	Irritable and restless	Resting well	None	Interrupted	Good	Morphine	
1	x																x	x	x	x				Slept at short intervals, had fair night
2		x														x		x	x	x				Fairly good night; slight pain
3			x														x	x	x		x			Ventral hernia and retroversion of uterus
4				x										x				x	x	x		x		Had to have morphine sulfate
5					x												x	x	x	x	x			Had fair day
6					x												x	x	x	x	x			Patient had numerous dense adhesions
7		x														x		x	x	x	x			Fairly good operative day
8						x											x	x	x		x			Perspiring, face flushed
9							x								x			x	x	x				Alcohol had no perceptible effect
10						x									x			x	x		x			Went to sleep after injection; felt like being drunk
11		x															x	x	x		x			Patient had flushed face, felt warm
12			x														x	x	x		x			Perspired freely, face flushed; inj. by hyperdermoclysis
13														x				x	x	x	x	x		Drowsy, had to give morphine for pain
14	x	4															x	x	x	x	x			Had good postoperative day; heat to abdomen,
15		x															x	x	x	x	x			Restless; had poor day
16		x															x	x	x	x	x	x		Only 1 inj. morphine necessary 8 hr. after intrav. inj.
17																	x	x	x	x	x			Drowsy and tingling sensation throughout body
18				x										x				x	x		x			Had pain but slept well after injection
19															x			x	x	x				Did not affect pain in lower abdomen
20								x									x	x	x		x			Had restful night; patient fairly comfortable
21									x								x	x	x		x			Complained of vertigo after injection was started
22	x															x		x	x		x			Vertigo
23																	x	x	x	x				Patient quiet although she did not go to sleep
24				x													x	x	x		x			Good postoperative day
25	x																x	x	x		x			Patient very drowsy; could not stay awake
26														x			x	x	x		x			Has a fair day
27															x		x	x	x		x			Patient slightly intoxicated
28																	x	x			x	x		Patient very restless
29	x																x	x			x	x		Patient very restless and uncooperative
30			x														x	x	x		x			Patient perspired moderately, pulse accelerated
	4	6	2	4	2	3	2	1	1	1	2	1	1	1	5	4	20	7	23	2	8	20	5	

Above cases were compiled from March 19, 1944 to July 13, 1944.

In most instances alcohol given intravenously postoperatively can replace the usual doses of morphine or other narcotics. The alcohol employed is the ordinary ethyl (95 per cent) alcohol as obtained from the manufacturers. Before intravenous injection, it is diluted with at least 120 to 240 cc. of saline solution or it may be added to the usual intravenous postoperative glucose, 5 per cent, and saline. As a rule we add 50

cc. of pure 95 per cent ethyl alcohol to 1,000 cc. of the glucose, 5 per cent, and saline solution. The rate of flow is regulated so as not to exceed more than 60 drops per minute. Intravenous injection of alcohol, if given too rapidly, may be painful and in a few patients has caused a slight sensation of syncope.

During the injection the patient very quickly experiences a feeling of well being

and is conscious of a gentle superficial warmth. If the pain for which the alcohol injection is given is not controlled and an excitable state persists, the injection may be repeated. In one patient, due to a nurse's misinterpretation of directions, 200 cc. of alcohol was given in twenty-four hours without deleterious effects except that it produced a too sound sleep associated with restlessness and a muttering stupor.

I have compiled a list of thirty consecutive operative cases in which intravenous alcohol was given postoperatively. Of these there were only five patients who postoperatively required morphine in addition to the alcohol. See table in next column.

The thirty listed cases include four of abdominal adhesions, six of acute appendicitis, two incisional hernias with retroversion of uterus, four of acute cholecystitis, two tubal pregnancies, three of subacute appendicitis, two of chronic appendicitis, one hysterectomy, one ptosis of kidney, one thyroidectomy, two of intestinal obstruc-

tion, one inguinal hernia, and one synovec-tomy (knee).

1	(4)	Mrs. A.	Cholecystitis	gr. $\frac{1}{8}$
2	(13)	Miss B.	Chronic appendicitis	gr. $\frac{1}{6}$
3	(16)	Mr. C.	Acute appendicitis	One inj. morphine 8 hrs. after alcohol injection.
4	(28)	Mr. D.	Intestinal obstruction	gr. $\frac{1}{8}$
5	(29)	Mr. E.	Adhesions; chronic appendicitis	gr. $\frac{1}{6}$

The results after intravenous injection of alcohol in glucose and saline were as follows: twenty had no pain, four had slight pain, in five pain was still severe, twenty-three rested well, seven were restless, two did not sleep, eight slept at intervals, twenty slept well, in one instance the effect on pain was not recorded.

Tabulated presentations of the results of the intravenous injection of alcohol are shown in Table 1.



# AN AMBULANT METHOD FOR THE TREATMENT OF PILONIDAL DISEASE\*

## A PRELIMINARY REPORT

J. L. MATHESHEIMER, M.D.

Proctologist, Greenville Hospital

JERSEY CITY, NEW JERSEY

WE have hesitated to present a paper on this method of treatment because all the cases except one occurred in our office practice and because of the small number of patients treated. However, the results, so far achieved, seem, we believe, to merit the presentation.

Seven patients were treated in all. They ranged from primary abscess formation to one patient with sinuses which were of twenty years' duration. Specifically there were two cases of primary abscess, two with recurrent abscess in an old operative scar. Two had a discharging sinus, one of which was a postoperative recurrence. One patient had three openings with sinuses (one of which was discharging), together with acute inflammation of the left buttock. In the group were five males and two females.

### METHOD OF TREATMENT

The patient is prepared by a thorough shaving of the operative area. It is important to keep the hair shaved about the wound while it is healing. The abscess or sinus is incised after skin infiltration with a water soluble analgesic. The tracts are opened by cutting down on a probe or groove director at different stages, so as not to have too large a wound. If more than one incision is contemplated, it is well to allow the wound made previously to fill with granulations partially before another incision is attempted. The wound, if there is much oozing, is packed with iodoform gauze. This gauze is removed on the second day. The wound is cleansed of any loose detritus by swabbing with hydro-

gen peroxide. The wound is then explored with a fine probe in order to ascertain its direction and also to see if there are any ramifications.

A solution which we had prepared for us is used to swab out the wound and to saturate the plain gauze packing which is inserted after the swabbing. The wound is kept packed with saturated gauze until the healing has reached the surface. Treatments following the incision are given every other day for eight or ten days or until the wound shows a healthy appearance. Thereafter twice weekly.

### SOLUTION

The solution, which is composed of ethylaminobenzoate twenty-five parts and phenmethylol seventy-five parts, when introduced into the wound produces a superficial, grayish-white coagulum accompanied by a slight burning sensation which shortly after changes to numbness. The lining membrane of the abscess or sinus apparently undergoes dehydration and after a few treatments desquamates leaving a healthy appearing surface. The solution seems to affect only the abnormal tissue. We have noticed when practically all the abnormal tissue has disappeared from the wound, and a small grayish-yellow spot still remains, this is a clue to probe for a possible extension of the tract. In probing one may also use the solution to advantage because of its anesthetic properties. Occasionally an excoriation around the wound edges is caused by the secretions. This is controlled by applying zinc oxide ointment.

\* Read before the New York Proctologic Society October 19, 1944.

## DURATION OF TREATMENT

The duration of treatment has been from eight to twelve weeks. It must be borne in mind that in every case, these patients have been at work all during the treatments. None of these patients is necessarily confined to his home more than one day.

## RESULTS

Of the seven patients, four have had no recurrence in from one to three years. One patient completed his treatments two months ago. One patient was called into the Navy before he could complete his treatments. In another case the patient had his abscess incised and was treated three times, then he discontinued coming and the wound healed. He was free of

symptoms for four years. He then had a recurrence at which time an abscess was again incised and a tuft of hair removed. One postoperative treatment was given. He has been free from any recurrence over two years. He feels good except when there is a change in the weather at which time he has a slight pain in the area.

## SUMMARY AND CONCLUSION

The treatment is an office procedure. The incision by stages leaves no large gaping wound thus obviating the confinement of the patient. The solution does not destroy the normal tissue and is an analgesic. The patient loses very few hours from his work. Further trial will be necessary in order to evaluate this method of treatment properly.



# UNDESCENDED TESTICLE

MILLARD S. ROSENBLATT, M.D.

Diplomate of the American Board of Surgery

PORTLAND, OREGON

THE ease with which the undescended testicle may be placed in the scrotum varies greatly. In difficult cases tedi-

its most distal attachment and also from its peritoneal attachment.

As there is practically always a hernial

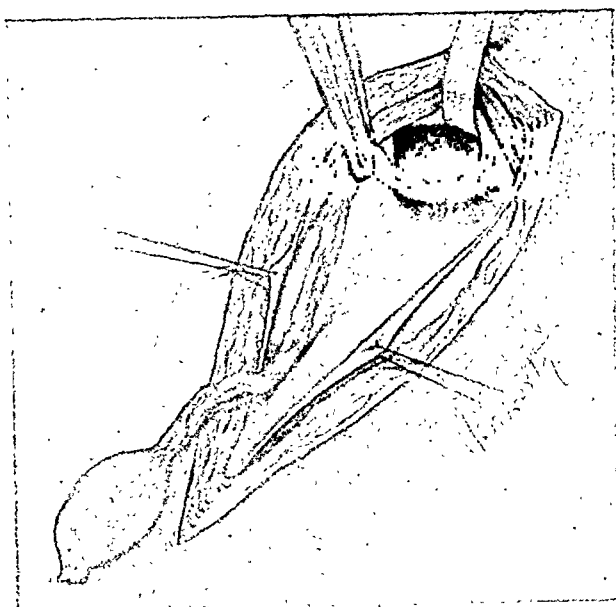


FIG. 1. Dissection of the spermatic cord from the under-neath surface of the posterior peritoneal wall after closure of the sack.

ous and painstaking dissection is necessary. The testicle must be freed with sufficient length to reach the scrotum without tension. If any considerable tension is required to hold it there, the vascular supply of the testicle will be interfered with and it will not develop properly.

The proper age for operation is between eight and nine years. In our experience the anterior pituitary-like substances have been of no avail, and when observing the mechanical nature of the disorder it is not reasonable to expect a hormone or medicine to help.

An inguinal incision is made and the external oblique fascia incised. The testicle is exposed and first dissected free from

sac associated, attention is then given to this. It is usually necessary to dissect the fine layer of peritoneum off the cord for the dorsal portion of the sac. The sac is then closed, but not transplanted. The most important place to free adhesions in addition to freeing the cord from its dorsal peritoneal attachment is along the posterior surface of the dorsal layer of the hernial sac. The internal oblique muscle and the closed sac must be lifted by gentle retraction and the dissection pursued as high up as can be reached. No other maneuver will derive so much length for the cord and in many cases the failure to do this will prevent the testicle from being lengthened sufficiently to bring it into the sac.

If the case is bilateral only one side should be operated upon at one sitting, the other being done a week later. If both sides are attempted on the same day, speed and hurry will inadvertently creep in and defeat the careful dissection in some cases.

The modified Ferguson type hernial repair is used for closure. A purse-string suture in the deep layer of the superficial fascia is taken at the top of the scrotum to help keep the testicle from working up into the groin. A suture of kaldermic No. 1 is placed in the tunica vaginalis of the testicle and brought out in two adjacent places through the scrotum and a rubber

band attached to it and strapped to the leg with very slight traction. The legs are not strapped together so that flexion of the thigh may release the traction from time to time. At the end of four days this suture is removed.

#### SUMMARY

1. Various points in relation to surgery of the undescended testicle are discussed.
2. The freeing of adhesions from the underneath surface of the hernial sac high above the internal inguinal ring is of the most valuable aid in lengthening the cord.



BILATERAL vasectomy is frequently done preliminary to prostatectomy to avoid postoperative epididymitis. This operation is also indicated when sterilization of the male is advisable.

From "Operations of General Surgery" by Thomas G. Orr (W. B. Saunders Company).



# A PROCEDURE FOR PREVENTING WOUND CONTAMINATION DURING APPENDECTOMY

BERNARD J. FICARRA, M.D.\*  
Resident Surgeon, Kings County Hospital  
BROOKLYN, NEW YORK

EVERY surgeon has had the experience of having an acute gangrenous appendix burst during its removal. The Our procedure is very simple. After the appendix has been liberated from its mesenteric attachment, a sterile finger cot

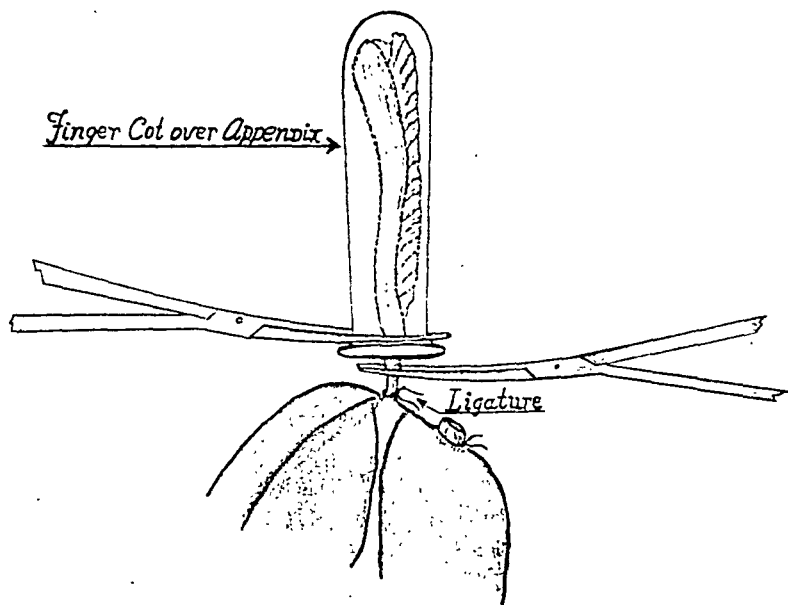


FIG. 1. The appendix is encased in a finger cot which is held securely with a clamp. An alternate method is to employ a ligature in place of the clamp.

subsequent contamination of the operative incision often results in a wound infection. Such infections increase the patient's period of hospitalization by many days and often weeks.

In the operative management of a patient with gangrenous appendicitis we have employed a simple method against wound contamination. By employing a sterile finger cot over the inflamed appendix, contamination of the operative field is prevented even if the appendix should perforate during its manipulation.

is placed over the appendix distally as far as necessary. At the distal end the finger cot is either clamped or ligated snugly about the appendix. (Fig. 1.) Appendectomy is then completed in the routine fashion, and the specimen is removed encased in the rubber sheath.

The finger cots employed are sterilized similar to the ordinary rubber drains and are kept in the same solution with the drains. On occasion when cots were not available, we have employed rubber fingers removed from old discarded rubber gloves.

\* At present Fellow in Surgery, Lahey Clinic, Boston, Mass.

The utilization of this method has been most facile and easy to follow. In those patients in whom the condition is most acute, the appendix is most distended and the cot is applied with greater ease. When the appendix is only slightly inflamed this procedure is not as easy to follow. How-

ever, in such instances the danger of perforation is not present.

On the occasions when this method has been employed, it is believed that the incidence of wound infections has been lowered via this simple prophylactic measure.



SUDDEN hemiplegia or even severe abdominal pain, as well as sciatica and other pains referred to nerves, may be due to a small neurofibroma of the spine, which in turn may be due to metastases from other areas, especially the lungs.

From "Metastases Medical and Surgical" by Malford W. Thewlis (Charlotte Medical Press).

# Case Reports

## HEALING OF PATHOLOGICAL FRACTURES THROUGH METASTASES FROM CARCINOMA OF THE BREAST

FREDERIC W. BANCROFT, M.D. AND JOHN M. BEAL, M.D.

NEW YORK, NEW YORK

**B**ECAUSE of a case of carcinoma of the breast with multiple osseous metastases and eight pathological fractures, five of which were shown to have healed, a brief review of the literature and an abstract of this case was thought to be of value.

The importance of this problem is accentuated by recalling that of all carcinoma, breast cancer ranks third in order<sup>1</sup> and that in some series, the incidence of osseous metastases is 17.8 per cent,<sup>2</sup> and as high as 37 per cent<sup>3</sup> in others. Bone is the third commonest site for metastasis in breast carcinoma, osseous metastases appearing most frequently in the lumbar vertebrae and in the upper ends of the femora.<sup>4</sup> The histologic appearance of the primary tumor is not related to the extent of metastasis.<sup>4</sup>

It has been maintained by many that pathological fractures will not heal unless treated by x-ray, and by others that such fractures will not heal at all because of the presence of tumor tissue at the fracture site. Such views apparently have root in Grunert's statement<sup>5</sup> that "in true carcinomatous metastases, union of fragments can never occur." Bloodgood<sup>6</sup> and Codman<sup>7</sup> concurred with this later.

A dissenting view was held by Kohler<sup>8</sup> who reported several healed fractures through metastatic carcinoma. In 1936, Welch<sup>9</sup> reviewed the literature and reported fifty-three cases with sixty-six fractures (49 per cent of which were from breast carcinoma), stating that 5 per cent healed with firm union, 9 per cent showed

moderate healing, and no evidence of healing was obtained in 80 per cent. In his series, the average length of life following fracture through carcinoma was less than six months.

The following case is that of a fifty year old white woman who suffered eight pathological fractures, the first four years and eight months after radical mastectomy for carcinoma of the breast. There has been no evidence of local or axillary recurrence, and the patient has subsequently had seven more fractures in a period of two and one-half years. Only one of these fractures was subjected to x-ray therapy and five have demonstrated both clinical and roentgenological evidence of firm union. Three have not been examined radiologically subsequent to fracture, although clinically two have united. One clavicle was still the site of pain and union did not seem complete. There was some question of re-fracture in this clavicle.

### CASE REPORT

A. H. (No. 35200), a fifty year old white, married, Turkish-born woman, entered The New York Hospital for the first time on June 30, 1936, complaining of a painless lump in the right breast, first noticed one week before admission. Her past history was negative except for cholecystectomy in October, 1927. She had had no pregnancies. On July 1, 1936, right radical mastectomy was performed. The surgical pathological report was medullary and scirrhous carcinoma of the breast with axillary metastasis. The postoperative course was uneventful and the patient was discharged on the eleventh postoperative day.

The patient was re-admitted on March 15, 1941, complaining of pain in the left thigh of two weeks' duration. The day of admission the leg gave way beneath her while walking. Examination was unremarkable except for signs of fracture of the middle third of the left femur and x-ray examination revealed pathological fracture. In addition metastases were noted in the left ischium, pubis and ilium, fifth lumbar vertebra and sacrum.

Russell traction was maintained for one month and she was then placed in a hip spica for six weeks, when x-ray examination revealed callous formation. X-ray therapy (1,500 r) was given to the fracture site through a window in the cast. The patient was walking with the aid of crutches three months after the fracture had occurred.

From October 3, 1941, to November 3, 1941, the patient received x-ray therapy to the entire spine and pelvis. Scalp nodules were noted December 22, 1941, and skull plates revealed multiple osteolytic areas of metastasis. X-ray therapy was then given to the skull.

The patient was re-admitted July 10, 1942, complaining of pain in her head and spine of six months' duration. X-rays revealed further extension of metastasis with collapse of the ninth dorsal vertebra. Further x-ray therapy to the spine was instituted.

On February 6, 1943, the patient was admitted for the fourth time, complaining of pain in the right arm and left leg of four hours' duration, following a fall in the tub. X-ray

patient turned in bed and four days later the right clavicle was also fractured. On March 24, 1943, the casts were removed, x-rays showing good callous formation. She was discharged three days later in a wheel chair.

The patient was re-admitted on September 9, 1943, with a pathological fracture of the left humerus of twenty-four hours' duration. A hanging cast was applied and removed five weeks later, when x-rays revealed union. One week before removal of the arm cast, pathological fracture of the right femur occurred. The femur was immobilized in a hip spica which was left in place for five weeks and the patient discharged, x-rays showing good callous formation and clinically union was satisfactory.

#### SUMMARY

A case report is presented with eight pathological fractures, five of which definitely healed. The fractures occurred over five years after radical amputation of the breast for carcinoma. It is interesting to note that the union from the first pathological fracture of the femur was strong enough so that the patient was able to walk without difficulty. She later refractured this same femur, but not in the same place.

#### REFERENCES

1. Statistical Bulletin of Metropolitan Life Insurance Co., 19: 7, March, 1938.
2. HAAGENSEN, C. D. and STOUT, A. P. Carcinoma of breast. *Ann. Surg.*, 116: 801, 1942.
3. SAPHIR, O. and PARKER, M. L. Metastasis of primary carcinoma of the breast. *Arch. Surg.*, 42: 1003, 1941.
4. WARREN, S. and WITHAM, E. M. The distribution of metastases in carcinoma of the breast. *Surg., Gynec. & Obst.*, 57: 81, 1933.
5. GRUNERT, D. Über pathologische Frakturen. *Deutsche Ztschr. f. Chir.*, 76: 254, 1905.
6. BLOODGOOD, J. C. Pathological Fractures. In Scudder, The Treatment of Fractures. P. 1019. Philadelphia, 1928. W. B. Saunders.
7. CODMAN, E. A. Pathological fractures. *Surg., Gynec. & Obst.*, 34: 611, 1922.
8. KOHLER, A. Über die Behandlung von Knochenbrüchen mit Roentgenstrahlen. *Deutsche. Ztschr. f. Chir.*, 147: 105, 1918.
9. WELCH, C. E. Pathological fractures due to malignant disease. *Surg., Gynec. & Obst.* 62: 735, 1936.

PHOSPHORUS, CALCIUM AND PHOSPHATASE DETERMINATIONS

	Serum Phosphorus	Serum Phosphatase	Serum Calcium	Acid Phosphatase
7/14/42	3.6	4.6		6.3
9/13/43	4.1	10.5		
9/15/43	4.3	11.3	10.6	

showed pathological fractures of the right humerus and left femur. The patient was placed in traction for one month and then a hip spica and hanging cast were applied. On March 12, 1943, the left clavicle was fractured when the



# INTRAPELVIC PROTRUSION OF THE ACETABULI

CAPTAIN J. C. THOROUGHMAN

MEDICAL CORPS, ARMY OF THE UNITED STATES

INASMUCH as the etiology of intrapelvic protrusion is still a matter of discussion, this case is being reported because it is somewhat unique in that hip symptoms are completely absent except for pain in the right knee.

Since Otto's original description in 1824, Pomeranz<sup>21</sup> was able in 1933 to collect only forty-one acceptable cases. To these Rechtman<sup>23</sup> added fourteen cases from subsequent literature, plus five of his own cases in 1936. Although there have been more frequent reports in the later literature, the total acceptable cases number only around one hundred. Mayoral<sup>17</sup> states that he found only one case in 33,709 roentgenological examinations.

Intrapelvic protrusion has at various times been designated as Otto's pelvis, protrusion acetabuli, and arthrokataclasis, a term suggested by Verrall.<sup>29</sup> White,<sup>31</sup> in 1884, described the first case of intrapelvic protrusion we were able to discover in the English literature. Hertzler,<sup>10</sup> in 1922, reported the first case in this country. Kohler<sup>12</sup> credits Kienbock with making the first roentgenological observations. The Germans have written at length on this condition.

The greatest discussion in the literature has centered around the etiology, most authors agreeing, however, that this condition is not a disease entity. The question may be somewhat simplified by dividing the cases into three general categories:

1. Those deformities following trauma or metastatic processes. These should not be classified as examples of Otto's pelvis.

2. Cases following acute or chronic infections. Mayoral's<sup>17</sup> case report includes three x-rays, the first showing only an infectious arthritis, the second thirty-four months later, showing a fully developed protrusion, and a third x-ray eleven months

later showing a quiescent lesion. The associated infections were a staphylococcic arthritis of the knee, an osteomyelitis of the femur, and a streptococcus infection of the ankle. As an amputation was performed for the bone disease, weight-bearing played no part in the development, and the mechanical force contributing to the deformity was attributed to muscle spasm. Sloane and Frauenthal<sup>27</sup> exhibit an interesting series of x-rays in the development of the protrusion, which they believed was the result of a Neisserian infection. The gonococcus is a favorite etiologic agent with many of the authors and is associated with too many cases to be entirely coincidental. Pomeranz,<sup>21</sup> who has an excellent summary of cases reported up to 1932, favors the infectious origin for all cases, and thinks that there are two types, (1) an acute type probably infectious in origin, and (2) a chronic type occurring in the course of any disease resulting in a localized osteomalacia of the acetabulum provided the femoral head maintains its boring qualities. He believes that this condition represents, "an atypical but essentially non-specific arthritis of the hip joint." Deformities following tuberculosis and echinococcus have been cited in the literature, but would seem to fall outside the scope of consideration.

3. The case reported here is typical of the third group and illustrates Doub's<sup>3</sup> theory of a general disease in early life causing a softening of the bones with a resulting deformity, the osteo-arthritis representing a later stage in the process. Pomeranz<sup>21</sup> states that Eppinger was the first to suggest that a disturbance of acetabular development is responsible for the condition. Rechtman<sup>23</sup> believes that "the prime factor is a pre-existing deep acetabulum" and that "the many etiological

factors suggested (formerly) were therefore probably only the irritating agents acting on an area of potential weakness." Gilmour<sup>6</sup> in an extensive discussion, believes that the primary disorder is "a premature acceleration of primary epiphyseal ossification" whereby the epiphyses are converted into young vascular bone which is ill adapted to resist strain and thus accounts for the bilateral occurrence, and the more frequent occurrence in females. He states that there is a concomitant slight coxa vara, and thinks that the osteo-arthritis is due to the result of a capsular shortening and a disturbance of the fluid mechanism of the joint. In the opinion of Gilmour, the uncomplicated deformity remains painless until degenerative or irritative changes occur. Maldevelopment of the acetabulum in one direction results in a shallow acetabulum with dislocation, and maldevelopment in the other direction in a deep acetabulum. In line with this theory, two of Rechtman's<sup>23</sup> cases suggest a familial factor, and Gickler<sup>5</sup> has written an article entitled, "Familial Occurrence of Protrusio Acetabuli; Etiology."

*Symptoms.* Our own patient was symptomless except for pain in one knee. Many authors believe that, aside from the acute infectious cases, intrapelvic protrusion is frequently asymptomatic until osteo-arthritis occurs, or until trauma or infection calls attention to the condition. The symptoms are those of arthritis and of the mechanical limitation of motion. Several cases are on record of the deep acetabuli complicating parturition.

*Physical Findings.* The most constant physical findings are limitation of motion, particularly in abduction and external rotation. There is a rather constant flexion deformity with a compensatory lordosis. Gilmour<sup>6</sup> has called attention to the alterations in the pelvic measurements and says that the intertuberous diameter is always less than normal. He also states that there is an increase in the intercrystal diameter with a relative reduction in the bitrochanteric diameter. Some observers have been

able to feel the protruding acetabuli through the abdominal wall and on rectal examination. We believe this was possible in our case.



FIG. 1. Lateral view showing flexion of lower extremities and compensatory lordosis.

*X-ray Findings.* These have been repeatedly described in the literature and are noted in detail in the case report given below.

*Therapy.* Therapy is unsatisfactory; diathermy, radiant heat, massage, traction, salicylates, plaster casts, arthroplasty

and arthrodesis have all been used. (Figs. 1 and 2.)

#### CASE REPORT

The patient, admitted to Oliver General Hospital on June 27, 1944, a colored male, twenty-five years of age, first sought medical

The patient denied serious illnesses or injury. There was no history of knee injury. He had gonorrhea in 1934 and was treated by pills and injections and declared "cured" in less than ten days. Another attack of gonorrhea in 1943 was treated with sulfonamides. The discharge lasted only three or four days.



FIG. 2. X-rays showing bilateral intrapelvic protrusion.

attention in July, 1943, for pain and stiffness in the knees following prolonged marching. He received heat treatments for one month with no improvement. X-rays of the knees taken at that time were said to be negative. The symptoms were relieved after he was assigned to the lighter duties of truck driving, and for about six months thereafter he was symptom free. He next sought medical attention in April, 1944, when pain in both knees was noted with some "cramping in knee," more pronounced on the right side. X-rays of the hip joint revealed a moderate protrusion acetabuli. He first came under our care June 27, 1944. At no time had there been any complaint of pain in the hips. The only symptom was that of aching discomfort beneath the patella.

The positive physical findings were as follows: Height 5 feet 5 inches; weight 152 pounds; pupils: round, regular, equal; reacted sluggishly to light; nose: irregularly deviated septum, non-obstructive, mucosa thickened and moderately injected. throat: tonsils hypertrophied and chronically inflamed; pulse 72; blood pressure 116/70. hernia: slight dilatation of the left ring with a transmitted impulse on coughing; abdominal: on deep palpation in the left lower quadrant, the acetabulum was barely palpable; genito-urinary: slight thickening of the right epididymis. The prostate was normal in size, not tender, and a very slight quantity of secretion was expressed on massage. The first and second glasses of urine were clear. On rectal examination, the acetabular protrusion on the left side could be made out.

Reflexes: the right knee jerk is less pronounced than the left. The Achilles tendon reflex was more pronounced on the right side.

In the standing position, there was marked lumbar lordosis. He walked guardedly with a limp to the right and avoided putting his weight on his right lower extremity. As he walked, the marked lumbar lordosis was maintained. All motion of the dorsolumbar spine was free. In supine position on the examining table, the patient kept both knees flexed. When the lumbar spine was flattened by flexing the left hip, there was a flexion deformity of 40 degrees and 15 degree abduction of the right hip. When the right hip was flexed, there was a flexion deformity of 40 degrees on the left side, and the limb was held in neutral position. Flexion of the hips was possible to an angle of 60 degrees on the right side and 85 degrees on the left. Internal and external rotation was completely restricted. Abduction was restricted on both sides. Motion of the knees was free and normal, but on the examining table, the patient was unable to extend the knees completely on account of the flexion deformity of the hips. On the right side, extension was maintained at an angle of 170 degrees, and 160 degrees on the left. Motion of the ankle joints and metatarsophalangeal joints was free. Circumference of the right thigh six inches above mid-patella was  $17\frac{1}{2}$  inches; left thigh the same. Motion of the joints of both upper extremities was free. There was no evidence of arthritis.

X-ray findings of the right knee and sinuses were negative. Both acetabula were quite deep and the floor was quite thin and consisted of a shell-like bone which protruded into the pelvis. The joint space of each hip was markedly reduced, and there was evidence of marked hypertrophic changes along the margins of the joint with some flattening of the head of each femur where it joined the neck. The lower portion of the spine and the sacroiliac joints were normal in appearance. This is typical of protrusio acetabuli.

Chest x-ray showed the trachea in the mid-line. Heart and great vessels were within normal limits. Apices and costophrenic angles were clear and the lung fields were normal. The thoracic cage revealed nothing abnormal. The right wrist was normal, except for a separate center of ossification of the styloid process of the ulna, which had not fused. The left wrist was normal as were also the hands.

Laboratory Data: Blood count: red blood cells 4,880,000. hemoglobin 104 (Sahli). white blood cells 6,150. differential: polymorphonuclears 60 per cent, eosinophiles 4 per cent, lymphocytes 36 per cent. Urinalysis: color, straw; cloudy; reaction, acid; albumen, negative; sugar, negative; microscopic 10 to 18 white blood cells to high power field; sedimentation rate: 4 mm. in one hour. Culture for gonococci (prostatic secretion): negative; blood chemistry: calcium 12.5 mg. per cent; phosphorus 4.4 mg. per cent; phosphatase 5 units. Tuberculin test: negative. No parasites or ova were found in the stool.

*Comment.* The case herein reported presents the classical picture of intrapelvic protrusion. It is unusual in that there were no symptoms referable to the hip other than knee pain on one side. Physical examination and x-ray of the knees revealed no evidence of knee disorder, nor were osteo-arthritic changes demonstrable in other locations. Some of the theories of etiology have been cited and correlated. We have no new suggestions as to etiology.

#### REFERENCES

1. BERG, CARL. Intrapelvic protrusion of the acetabulum. *Surg. Clin. North America*, 20: 863-867 1940.
2. CARY, AUSTIN N. and BARNARD, LEONARD. Arthrokatachysis of the hip joint. *J. Bone & Joint Surg.*, 14: 687-689, 1932.
3. DOUB, HOWARD P. Intrapelvic protrusion of the acetabulum. *Radiology*, 12: 369-376, 1929.
4. GELLMAN, MOSES. Arthrokatachysis of the hip joint. *South. M. J.*, 27: 215-219, 1934.
5. GICKLER, Familial occurrence of protrusio acetabuli; etiology. *Ztschr. f. Orthop.*, 66: 14-20, 1937.
6. GILMOUR, JOHN. Adolescent deformities of the acetabulum—an investigation into the nature of protrusio acetabuli. *Brit. J. Surg.*, 26: 670-699, 1939.
7. GILMOUR, JOHN. The relationship of acetabular deformity to spontaneous osteo-arthritis of the hip joint. *Brit. J. Surg.*, 26: 700-704, 1939.
8. GOLDING, F. CAMPBELL. Protrusio acetabuli (central luxation). *Brit. J. Surg.*, 22: 56-62, 1934.
9. HERTZLER, ARTHUR E. Surgical pathology of the diseases of bones. P. 120-122. Chicago, 1930, Lakeside Press.
10. HERTZLER, ARTHUR E. Osteo-arthritic protrusion of the acetabulum (intrapelvic Pfannenvorwölbung). *Arch. Surg.*, 5: 691, 1922.
11. HILT, LAWRENCE M. Intrapelvic protrusion of the acetabulum or Otto's pelvis. *Illinois M. J.*, 70: 443-444, 1936.



12. KOHLER, ALBAN. The Borderlands of the Normal and Early Pathological in the Skiagram. Pp. 220-222. Baltimore, 1935. William Wood & Company.
13. LEVIN, WALTER N. Intrapelvic protrusion of the acetabulum (Otto's pelvis). *J. A. M. A.*, 105: 112, 1935.
14. LEVINTHAL, DANIEL H. and WOLIN, IRVING. Arthrokataclasis of the hip joint. *Radiology*, 25: 580-585, 1935.
15. LEWIN, PHILLIP. Osteo-arthritic protrusion of the acetabulum. *Surg., Gynec., & Obst.*, 41: 449-450, 1925.
16. LIPSCOMB, PAUL R. and CHATTERTON, CARL C. Osteo-chondritis juvenilis of the acetabulum. *J. Bone & Joint Surg.*, 24: 372-381, 1942.
17. MAYORAL, A. Non-traumatic protrusion of the acetabulum. *South M. J.*, 30: 1163-1165, 1937.
18. MERCER, WALTER. Orthopedic Surgery. Pp. 413-416. London, 1936. Arnold.
19. NICHOLAS, B. H. and SHIFTELT, E. L. Intrapelvic protrusion of the acetabulum (Otto's pelvis). *Amer. J. Roentgenol. & Radium Therap.*, 31: 346-348, 1934.
20. PLEWES, L. W. Osteo-arthritis of the hip. *Brit. J. Surg.*, 27: 682-695, 1940.
21. POMERANZ, MAURICE M. Intrapelvic protrusion of the acetabulum (Otto's pelvis). *J. Bone & Joint Surg.*, 14: 663-686, 1932.
22. POMERANZ, MAURICE M. Osteo-arthritic protrusion of the acetabulum. A case report. *Amer. J. Surg.*, 39: 169-170, 1925.
23. RECHTMAN, A. M. Etiology of deep acetabulum—an intrapelvic protrusion. *Arch. Surg.*, 33: 122-137, 1936.
24. REED, EDWARD N. A case of arthrokataclasis of the hip joint. *J. Bone & Joint Surg.*, 15: 802-803, 1933.
25. SCHIAAP, C. Intrapelvic protrusion of the acetabulum. *J. Bone & Joint Surg.*, 16: 811-815, 1934.
26. SHANDS, A. R. Handbook of Orthopaedic Surgery, Pp. 381-382. St. Louis, 1940. Mosby.
27. SLOANE, DAVID and FRAUENTHAL, MARIAN. Acute Neisserian intrapelvic protrusion of the acetabulum (Otto's pelvis). *J. Bone & Joint Surg.*, 19: 843-846, 1937.
28. SMITH-PETERSEN, M. N. Treatment of malum coxae senilis, old slipped upper femoral epiphysis, intrapelvic protrusion of the acetabulum and coxa plana by means of acetabuloplasty. *J. Bone & Joint Surg.*, 18: 869-880, 1936.
29. VERRALL, P. JENNER. An unusual bilateral condition of the acetabula. *J. Bone & Joint Surg.*, 11: 39, 1929.
30. WARDELL, W. H. A case of unilateral intrapelvic protrusion of the acetabulum—so-called arthrokataclasis. *Canad. M. A. J.*, 38: 267-268, 1938.
31. WHITE, W. HALE. On Charcot's joint disease. *Lancet*, 1: 366-369, 1884.
32. WHITE, W. HALE. Charcot's joint disease. *Lancet*, 2: 136, 1884.



# INFECTED URACHAL CYSTS

NATHAN BRODIE, M.D.

Assistant Surgeon, Kings County Hospital, Brooklyn Cancer Institute and Israel Zion Hospital  
BROOKLYN, NEW YORK

CYSTS resulting from a patent urachus are a relatively rare condition, are frequently undiagnosed and usually give rise to no symptoms unless they become infected.

*Embryology.* Dreyfuss<sup>1</sup> describes the urachus in post-embryonic life as representing an involuted structure. Originally, it was a part of the fetal bladder. The bladder is formed, except for the trigone and the region of the ureteral openings, by a division of the common cavity of the cloaca by a septum forming the posteriorly located rectum and the anteriorly located bladder. The primitive cloacal epithelium becomes modified to meet the physiologic purposes of the final organ. The fetal bladder extends up to the umbilicus where it continues into the allantoic stalk which also carries the umbilical vessels and is better known as the umbilical cord. Eventually, the upper half of the bladder narrows, the lower half retires behind the protective barrier of the pubic bone and all that remains of the upper half is a duct-like structure, the urachus.

*Anatomy.* Lowsley and Kirwin<sup>2</sup> state that in the normal adult, the urachus reaches only one-third of the distance from its point of attachment at the apex of the bladder to the umbilicus and is attached to the posterior aspect of the navel by the fibrous remnants of the obliterated hypogastric arteries. Begg<sup>3</sup> states that the urachal epithelial canal is never completely obliterated by fibrous tissue but retains a bore of 1 mm. Lowsley and Kirwin<sup>2</sup> add that ordinarily, however, this small channel is completely obstructed at birth by proliferated and shed epithelial cells and debris which accounts for the rarity with which urine is found to pass upward from the bladder. The epithelial

cells tend to proliferate outward into the dense connective tissue layer which surrounds and supports the lining membrane of the normal urachus.

*Pathology.* Lowsley and Kirwin<sup>2</sup> state that in approximately two out of three persons, the lumen of the urachus is separated from the bladder proper by a transverse mucous fold but in the third instance, this partition fails to develop, the lumen remaining completely or partially patent and what is known clinically as persistent or patent urachus occurs. Acquired abnormalities are the result of urinary obstruction either with or without some defect of development.

When the urachus remains patent, it may assume any one of four variations according to Long:<sup>4</sup> (1) *Complete type:* This consists of the urachus communicating with the bladder and umbilicus. (2) *Blind external type:* In this type, the urachus communicates with the umbilicus. (3) *Blind internal type:* This may be described as failure of obliteration at the bladder. (4) *Totally blind type:* Obliteration, in this type, takes place at the umbilicus and the bladder but patency occurs at some point between the two.

To these, Lowsley and Kirwin<sup>2</sup> add a fifth condition, vesico-umbilical fistula in a fetal type bladder, one that fails to descend.

The blind external type may produce a mucoid or mucopurulent discharge and later a granuloma. The blind internal type may persist unrecognized through life. However, when associated with obstruction of the lower urinary tract, it may result in a diverticulum. Lowsley and Kirwin<sup>2</sup> comment that infection with discharge into the bladder will account for some cases of recalcitrant cystitis and

pyruia. In the presence of lower tract obstruction or increased intravesical pressure, urine escaping into an open terminal urachal canal may extravasate to the umbilicus thus to be discharged at the external surface converting the external blind canal into a completely patent urachus. These acquired patent canals are confirmed in the literature with congenital patent urachus.

Some of the complications of patent urachus are exstrophy of the bladder, tumors benign or malignant, cysts, abscesses, cavities between the bladder and umbilicus, calculi and tuberculosis. We are concerned in this article mainly with urachal cysts.

*Incidence of Patent Urachus.* Patent urachus is a comparatively rare condition. Herbst,<sup>5</sup> in 1937, stated that a careful review of the literature disclosed 148 cases in the previous four centuries. Dudgeon,<sup>6</sup> in 1938, stated that only about 150 cases had been reported since 1550. The same writer,<sup>7</sup> in 1940, stated that there were 154 such cases reported up to 1936 to which he now added seven and that male cases exceeded female in a ratio of about two to one.

Mahoney<sup>8</sup> found a patent urachus three times in a total of 200,000 admissions to the Children's and Infant's Hospital in Boston. Campbell<sup>9</sup> reports fifteen such cases in 12,080 autopsies on children. Bandler and associates<sup>10</sup> found that in over 100,000 admissions to the New York Post-Graduate Hospital only three cases of patent urachus were found. Herbst<sup>5</sup> states that the earliest case in the literature was the one reported by Cabral in 1550.

#### URACHAL CYSTS

*General Description.* Dreyfuss<sup>1</sup> states that probably most of the urachal cysts are retention cysts. Half of them are found close to the bladder into which some of them open. They sometimes attain tremendous size and the largest one that has been described contained many liters of urine-like fluid. Yoerg<sup>11</sup> states that while

urachal cysts are uncommon, the condition probably occurs more often than the small number of cases reported would indicate. Cross,<sup>12</sup> in 1935, found only ninety-six cases reported. Lowsley and Kirwin<sup>2</sup> assert that such cysts may form at any point between the apex of the bladder and the umbilicus if a small portion of the duct remains patent. The majority (over 50 per cent) are found at the vesical end. Bauer<sup>13</sup> makes the statement that they may contain urine, a mucoid fluid from the cyst wall, a serous transudate, pus, cholesterin, fat cells, epithelium or fibrin. Dreyfuss<sup>1</sup> includes blood and rarely concretions in his description.

Infection is present in practically all cysts that come to operation. Escherichia coli, streptococci and staphylococci have been reported. Many show no bacteria by smear or culture. Many observers believe that the entrance of bacteria is by way of the lymphatics or blood stream. Kantor,<sup>14</sup> while admitting that this possibility cannot be denied adds: "However, with previous communication with the bladder demonstrated, direct extension seems plausible in most cases. The tract may not be demonstrated because of subsequent obliteration." In regard to sterile cultures, he adds: "This is in accord with localized infection elsewhere which after a period of time may become sterile."

*Etiology.* Yoerg<sup>11</sup> makes the assertion that there is no agreement as to etiology. Some believe that the lacunae of Luschka enlarge to form cysts. Yoerg thinks, however, that it would hardly seem possible that these minute cavities could enlarge without a secreting lining. Although the bladder epithelium does not have a secreting function, it is of course possible that the epithelial lining may have changed its function to become secreting. An obstruction of the urine flow would account for the completely patent cyst but could not produce the internal blind cyst which is by far the commonest type.

*Symptoms and Physical Signs.* An uninfected urachal cyst gives rise to no

symptoms. An infected cyst will give rise to the general symptoms and physical signs of infection. A tender suprapubic mass, abdominal pain, tenderness, gastrointestinal symptoms, fever and leucocytosis often occur. Dysuria will occur if the cyst connects with the bladder and pyuria frequently accompanies this. A purulent or mucopurulent discharge from the umbilicus usually means the umbilical type of cyst. The diagnosis of urachal cyst is not easy. Rankin and Parker<sup>15</sup> maintain that relief is obtained by forward stooping and aggravation is obtained by deep breathing. Archibald<sup>16</sup> asserts that urachal cysts of moderate size are palpable below the umbilicus, sometimes to one side of the mid line, as rounded tumors often moving more freely from side to side than up and down and that movement of the tumor from side to side may produce an indrawing of the umbilicus. Other investigators have shown that those cysts that connect with the bladder can be demonstrated by cystoscopy and cystograms. Gastrointestinal symptoms may mean that perforation into the peritoneal cavity is imminent.

*Treatment.* The treatment of infected urachal cyst is purely surgical. Incision and drainage should be promptly performed. Lowsley and Kirwin<sup>2</sup> maintain that this should be followed by radical excision at a later date. Dreyfuss<sup>1</sup> likewise states that it may be necessary first to drain and to remove the cyst later as a secondary operation. He adds that an unfortunate complication would be perforation into the peritoneal cavity. Yoerg<sup>11</sup> asserts that in some cases the cysts can be removed completely without entering the peritoneal cavity. However, if infection is present, the cyst will usually be firmly adherent to the peritoneum and a conservative procedure is advisable, consisting of incision, curettage and free drainage. It appears that many of these infected cysts so treated will heal permanently. If, however, the sinus should persist, excision of the cyst can be done more safely later in the absence of acute infection for it is

usually necessary to enter the abdominal cavity to facilitate removal. In patent urachus connecting with the bladder, it is obvious that removal is necessary and that the opening in the bladder be closed.

*Review of the Literature.* The first clear picture of urachal cyst in the literature is found in an article published in 1886 by Lawson Tait<sup>17</sup> who reported twelve cases. Tait was also the first to have made a correct diagnosis preoperatively. However, Tait was preceded by some other surgeons as reported by Weiser<sup>18</sup> who, in 1906, made an extensive review of the literature of urachal cysts and collected eighty-six cases to which he added three of his own. In the eighty-six cases, nine were completely patent, seven externally blind, eight internally blind, forty-six blind at both ends and sixteen could not be classified. The first reports were by Hoffman (1870), Wolff (1873) and Atlee (1873). Wutz (1883) analyzed all alleged cases diagnosed clinically or at autopsy and said that most of them had been misdiagnosed or had questionable symptoms and he believed that there were definitely no clinically important urachal cysts up to that time. Weiser<sup>18</sup> asserts that much of the history in the eighty-six cases up to 1906 was meager and questionable. In the eighty-six cases, twenty-one were males, fifty-eight females and seven not stated. Weiser made the deduction that urachal cysts are most common in middle life for half of the cases in which the age was given occurred between twenty and forty years of age. He also deduced that such cysts occurred more often in females than in males. Weiser's own three cases were all large cysts, two in females and one in a male. Complete removal was performed with recovery. Doran,<sup>19</sup> in 1909, reported a case of urachal cyst simulating appendicular abscess and in his summary of the literature agreed with Wutz that up to 1883 no clinically important cysts were reported.

Pendl,<sup>20</sup> in 1914, reported a colloid carcinoma arising from a urachal cyst and cites Schwartz as having been the first to

have reported such a case (1912). De Waard<sup>21</sup> reported two similar cases in 1939 and Hughes and La Towsky<sup>22</sup> likewise reported two such cases (1942). Long<sup>23</sup> (1927) reported a dermoid cyst developing in a patent urachus and stated that such cases are rare and that he could find but six such cases previously reported. Hamm<sup>24</sup> (1940) reported a benign cystadenoma of the bladder probably of urachal origin.

Padovoni and Dufour,<sup>25</sup> in 1930, reported two cases of urachal cyst connecting with the umbilicus. One was resected and the other merely drained. They warned against resection as risking the danger of contaminating the peritoneal cavity with infected cyst contents.

Archibald<sup>16</sup> (1930) described a case of urachal cyst in a twenty-six-year old male. The symptoms resembled those of acute appendicitis. Resection was performed. The author claimed that resection can usually be performed without opening into the peritoneal cavity except when there are extensive adhesions.

Lubash<sup>26</sup> (1929) reported a case of a twenty-two-year old male with a urachal cyst connecting with the umbilicus. Resection was performed with recovery.

Schmidt<sup>27</sup> (1933) reported three cases of urachal malformations, one of a fetal type bladder with umbilical fistula in a four-year old boy upon whom he performed a resection of a conical section of the bladder; one small cyst with concretions in an eight-year old girl in which case the operation was resection, and one large cyst in a twenty-four-year old man which was resected.

Stevens<sup>28</sup> (1933) described a purulent urachal cyst connected with the umbilicus in a twenty-four-year old male which was resected and Douglass<sup>29</sup> (1933) reported two cases, one an infected urachal cyst in a woman of fifty-one which was drained and one case of urachal fistula discharging exteriorly and connecting with the bladder in a woman of thirty-two.

Cross,<sup>12</sup> in 1935, reviewed the literature comprising ninety-six cases of urachal

cysts and added one of his own which ruptured into the abdominal wall. Only one of the ninety-six cases reviewed took such a course although some ruptured into the bladder, the peritoneal cavity or externally through the umbilicus. In Cross's case, a fistulous tract leading to the bladder was found, packed and left wide open with complete recovery.

Gayet and Verrière<sup>30</sup> (1936) described a case of a sixty-nine year old man with a pedunculated urachal cyst, the pedicle being attached to the bladder. The cyst was resected, a portion of the bladder near the pedicle was also resected and the wound drained.

Dudgeon<sup>6</sup> (1938) reported five cases of urachal cysts four of which were resected and one large abscess of the urachus merely drained. All of the patients recovered.

Kantor<sup>14</sup> (1939) reviewed thirty-six cases of urachal cyst in the literature and added two of his own. One was in a two-year old female which was drained. The other was in a twenty-nine-year old male which was drained and was resected at a subsequent operation. Kantor made the statement: "It is suggested that where the diagnosis of infected urachus cyst is made, incision and drainage may be adequate to effect a cure. Where reoperation may be necessary, subsequent excision is more easily and safely performed."

Dudgeon<sup>7</sup> (1940) reported seven cases of patent urachus, six of which had cysts and gave a review of the 154 cases of patent urachus reported up to 1936. His summary of the 154 cases is as follows: 107 or 69.6 per cent recovered; thirteen or 8.4 per cent died; twenty-eight or 18.1 per cent were not cured; in six or 3.9 per cent the result was not reported. Of the 154 cases, seventy occurred in children under thirteen years of age. Of Dudgeon's seven cases of patent urachus, five had small infected cysts which were removed. One had a large urachal abscess which was drained. The six patients who were operated upon were all cured. The other patient refused operation.

Dreyfuss and Fliess<sup>31</sup> (1941) give an account of patent urachus with stone. Bandler and associates<sup>10</sup> (1942) likewise describe urachal calculi with a complete review of the literature of patent urachus.

Everett<sup>32</sup> (1942) described a case of peritonitis due to perforation of an infected urachal cyst. This was resected with drainage followed by recovery.

Yoerg<sup>11</sup> (1942) gave a very complete account of urachal cysts and a review of the literature. He described one new case of urachal cyst which connected with the umbilicus. Curetting the cavity followed by the application of 20 per cent silver nitrate cured the condition.

Powers<sup>33</sup> (1942) gave a good account of various suppurative processes of patent urachus.

Winer and Danciger<sup>34</sup> (1941) described tuberculous involvement of patent urachus.

Perez and Matera<sup>35</sup> (1942) reported a case of suppurating cyst of the urachus. Treatment was drainage and recovery resulted.

Fisher<sup>36</sup> (1942) reported the case of an infected urachal cyst in a four-month old female. Excision was performed with a postoperative sinus following.

Evans<sup>37</sup> (1942) reported a case of infected urachal cyst in a twenty-eight-year old male. Complete excision was performed with recovery.

#### CASE REPORT

x, a male infant, aged seven weeks, was first admitted to Israel Zion Hospital, April 20, 1943. Severe upper respiratory infection had occurred two weeks before onset.

His present illness began two days prior to admission. The symptoms consisted of acute urinary retention secondary to phimosis, the latter being treated by means of a dorsal slit. Simultaneously with the symptoms noted, three furuncles were found upon the lower abdominal wall. These were incised, each discharging a considerable amount of pus.

A suprapubic mass which had been noted at the time of the dorsal slit operation failed to disappear following catheterization; on the contrary, it progressively increased in size

during the next two days and became more tender and fluctuating.

Under general anesthesia, a median sub-umbilical incision one inch in length was made and 750 cc. of thick yellow pus evacuated. Two Gm. of sulfanilamide crystals were placed within the abscess cavity, a Penrose drain inserted and the cavity packed with two strips of iodoform gauze.

The postoperative course was uneventful. Sulfathiazole was administered orally for the next three days. The temperature returned to normal and the patient sent home on the seventh postoperative day.

Laboratory findings were as follows: Urine: Free from albumin, sugar and acetone; an occasional leucocyte and epithelial cell. Blood count: White cells 29,200; 64 per cent polymorphonuclear leucocytes, 36 per cent lymphocytes. The subsequent count postoperatively was 17,800 white cells with 62 per cent polymorphonuclear leucocytes, 4,120,000 red cells and 84 per cent hemoglobin.

Examination on May 16, 1943, revealed the wound to be completely healed with no further drainage. Two weeks later, a suprapubic swelling again appeared in the region of the operative scar. In two days, this mass increased in size rapidly and became tender and fluctuating. The temperature was 101.8°F.

On June 5th, the suprapubic scar was elevated and pus was visible beneath it. Pressure upon the suprapubic mass was followed by a purulent discharge from the umbilicus. A probe was inserted into the umbilicus caudad for a distance of 2 cm. Upon removal, purulent material was detected on the probe. A diagnosis of infected urachal cyst was made and the child again hospitalized.

At the second operation, under general anesthesia, an incision was made through the previous scar and 350 cc. of a thick yellowish green pus evacuated. The abscess cavity was explored digitally and found to be extraperitoneal but extending posteriorly to the left as far as the left lateral aspect of the mesosigmoid; 4 Gm. of sulfanilamide crystals were placed in the abscess cavity and the cavity was again packed with iodoform gauze.

Culture of the purulent fluid revealed *Streptococcus fecalis*, *Escherichia coli* and *Bacillus bifidus*.

The postoperative course was uneventful. The patient was discharged upon the seventh

day. The wound continued to drain until July 15th, followed by complete healing. The general condition of the infant has remained excellent since and there have been no further recurrences.

#### SUMMARY AND CONCLUSIONS

1. The anatomy, etiology and pathology of urachal cysts have been described.

2. Urachal cysts are relatively rare and follow a patent urachus. Such cysts cause no symptoms unless they become infected.

3. The symptoms of infected urachal cysts have been described and are the local and general symptoms of infection.

4. The treatment is surgical. Incision and drainage are usually sufficient. A few cases require resection. This is best postponed until a later date on account of the danger of peritonitis if it is performed at the original operation.

5. A case report is given in which incision and drainage of an infected urachal cyst was performed but had to be repeated once. Full recovery resulted.

6. A review of the literature has been added.

#### REFERENCES

1. DREYFUSS, M. L. Benign and malignant lesions of the urachus with special reference to the colloid carcinoma of the bladder. *Virginia M. Monthly*, 70: 200-204, 1943.
2. LOWSLEY, O. S. and KIRWIN, T. J. *Clinical Urology*. Baltimore, 1940. Williams & Wilkins.
3. BEGG, R. C. The colloid adenocarcinomata of the bladder vault arising from the epithelium of the urachal canal. *Brit. J. Surg.*, 18: 423, 1931.
4. LONG, J. L. Cysts of the urachus. *J. Oklahoma M. A.*, 24: 388-91, 1931.
5. HERBST, W. P. Patent urachus. *South. M. J.*, 30: 711-19, 1937.
6. DUDGEON, HOWARD, JR. Patent urachus. *Texas State J. Med.*, 34: 401, 1938.
7. DUDGEON, HOWARD, JR. Treatment of patent urachus with report of seven cases. *Surg., Gynec. & Obst.*, 71: 302, 1940.
8. MAHONEY, P. J. *New England J. Med.*, 215: 193, 1919.
9. CAMPBELL, M. F. *Pediatric Urology*. 1st ed., vol. 1, p. 306. New York, 1937. Macmillan.
10. BANDLER, C. G., MILBERT, A. H. and ALLEY, J. L. Urachal calculus with consideration of associated

- pathology of the urachus in adult life. *New York State J. Med.*, 42: 2203-9, 1942.
11. YOERG, OTTO W. Cysts of the urachus. *Minnesota Med.*, 25: 496-501, 1942.
12. CROSS, J. B. Cysts of the urachus. *J. Urol.*, 33: 408, 1935.
13. BAUER, C. Klinische Bedeutung und histologische Bau der Urachuszysten. *Ztschr. f. Urol.*, 25: 807, 1930.
14. KANTOR, H. I. Cysts of the urachus. Report of two cases. *Ann. Surg.*, 109: 277, 1939.
15. RANKIN, F. W. and PARKER, B. Tumors of the urachus with a report of seven cases. *Surg., Gynec. & Obst.*, 42: 19, 1926.
16. ARCHIBALD, R. Cysts of the urachus. *Brit. M. J.*, 3644: 771, 1930.
17. TAIT, LAWSON. Twelve cases of extraperitoneal cysts. *Brit. Gynec. J.*, 2: 328, 1886.
18. WEISER, W. R. Cysts of the urachus. *Ann. Surg.*, 44: 529, 1906.
19. DORAN, A. Urachal cyst simulating appendicular abscess. *Lancet*, 1: 1304-10, 1909.
20. PENDEL, F. Colloid carcinoma of a urachus cyst. *Beitr. z. klin. Chir.*, 91: 181, 1914.
21. DE WAARD, T. Two rare cases of cancer of the urachus. *J. Urol.*, 42: 554, 1939.
22. HUGHES, P. B. and LA TOWSKY, L. W. Colloid adenocarcinoma of the urachus. *Am. J. Surg.*, 58: 422-5, 1942.
23. LONG, J. H. Dermoid cysts of the urachus. *Surg. Clin. North America*, 7: 943, 1927.
24. HAMM, F. C. Benign cystadenoma of the bladder, probably of urachal origin. *J. Urol.*, 14: 227-33, 1940.
25. PADOVANI, P. and DUFOUR, A. Two cases of urachus cysts with umbilical fistula formation. *Ann. d'anat. Patol. Med. Clin.*, 7: 234, 1930.
26. LUBASH, S. Congenital cyst of urachus. *Am. J. Surg.*, 7: 851, 1929.
27. SCHMIDT, G. B. Malformations and diseases of the urachus. *Med. Klinik*, 29: 702, 1933.
28. STEVENS, A. R. Pyourachus with report of a case. *J. Urol.*, 30: 319, 1933.
29. DOUGLAS, M. Urachal cysts and fistulae. *Am. J. Surg.*, 22: 557, 1933.
30. GAYER and VERRIERE. Cysts of the urachus. *Lyon Chir.*, 33: 253, 1936.
31. DREYFUSS, M. L. and FLIESS, M. M. Patent urachus with stone formation. *J. Urol.*, 46: 771-81, 1941.
32. EVERETT, C. Peritonitis due to perforation of an infected urachus cyst with stone formation. *J. Urol.*, 46: 77-81, 1941.
33. POWERS, H. J. Patent urachus with chronic supuration. *Med. Bull. Vet. Admin.*, 18: 446-8, 1942.
34. WINER, J. H. and DANCIGER, J. A. *Am. J. Dis. Child.*, 61: 539-46, 1941.
35. PEREZ, B. and MATERA, R. F. Suppurated cyst of the urachus. *Rev. san. mil.*, 41: 651, 1942.
36. FISHER, W. E. Infected cyst of the urachus. *Quart. Bull. Indiana Univ. Med. Center*, 3: 115-17, 1941.
37. EVANS, R. L. Urachal cyst, infected. Report of a case. *Guthrie Clinic Bull.*, 11: 90, 1942.

# SQUAMOUS CELL CARCINOMA OF THE RENAL PELVIS\*

CHARLES J. E. KICKHAM, M.D.

Chief of Urological Service, St. Elizabeth's Hospital;  
Urologist, Carney Hospital

BOSTON, MASSACHUSETTS

AND

LIEUT. RICHARD H. STANTON

Former Resident in Surgery, St. Elizabeth's Hospital

MEDICAL CORPS, UNITED STATES

NAVAL RESERVE

THE incidence of non-papillary, squamous cell carcinoma of the renal pelvis is very low. The papillary neoplasms comprise the largest number of carcinoma of the pelvis of the kidney. In 1933 Swift-Joly collected 337 tumors of the renal pelvis from the literature and classified fifty of these as the non-papillary, squamous cell type. Additional cases have been reported by Scholl, MacMillan and Gilbert, Silverstone, Nicholson, and Priestly. In 1939, Higgins reported five cases and reviewed fifty-nine cases from the literature. Melicow, in 1944, in a review of the renal tumors encountered at the Squier Urological Clinic, reported thirteen cases of this type of lesion, a total of seventy-seven cases.

This unusual clinical and pathological entity needs emphasis in view of the viciousness of its local extension and metastatic spread, the extreme difficulty of preoperative diagnosis, and because of its frequent association with renal calculi and chronic kidney infection. The medical profession has long been cognizant of the deleterious effects of calculi on the kidney as on their heels interference with the normal outflow of urine, secondary infection, and progressive destruction of the renal parenchyma inevitably follow, but a fact not so readily appreciated is that an almost 100 per cent fatal sequella may at times be the development of malignant disease within the kidney. It is accepted by both pathologists and urologists that a small, but definite, group of renal tumors—the so-called non-papillary, squamous cell carcinoma of the renal pelvis—are etiologically related and associated

with calculous disease of the kidney. The high malignancy of this type of growth was emphasized by Higgins who was unable to find a single case from the literature in which the patient was free from metastasis five years after operation. The immediate mortality has also been exceptionally high. It is a neoplasm which rapidly causes death. Early diagnosis is extremely difficult and very unusual, as there is no clinical syndrome by which a positive diagnosis can be made. The co-existence of calculi, renal infection, or both may direct the attention of the attending surgeon away from the possibility of tumor except in an occasional instance in which urographic study may delineate a characteristic filling defect in the renal pelvis. The diagnosis is most frequently made at the time of operation or by the pathologist.

Kretschmer, in 1917, stated that the weight of evidence pointed to chronic inflammation resulting from renal calculi or infection playing the major rôle in the development of this type of cancer. As a result of longstanding irritation the normal epithelium of the renal pelvis, which has been referred to as transitional in type, undergoes metaplasia and develops stratified squamous epithelium and subsequently varying degrees of leucoplakia. Malignant degeneration later takes place. A characteristic feature of the squamous cell neoplasm is that the tumor cells have keratinized and produce prickle cells, or so-called pearly and onion bodies. As distinguished from the papillary carcinoma of the renal pelvis these growths extend by direct invasion of the kidney proper, peri-

\* From the Department of Urology, St. Elizabeth's Hospital, Boston, Mass.



renal tissues and local lymphatics, as well as by early distant metastasis to the liver, lungs and long bones. The papillary neo-

tion, and as far as she was aware she had passed no blood in the urine. There had been some loss of weight which she attributed to



FIG. 1. X-ray plate showing multiple giant calculi of the left kidney and a large calculus in the lower left ureter.

plasms spread by transplantation of tumor cells along the ureter. Implants in the bladder, proximate to the ureteral orifice of the involved side, may at times be noted. Obviously, therefore, in view of the different life habit of these tumors, the surgical management differs. Ordinary nephrectomy with removal of the proximal ureter suffices for the non-papillary type, while nephroureterectomy with segmental resection of the intramural portion of the bladder is the ideal method for the papillary lesions.

#### CASE REPORT

Case No. C-59223, St. Elizabeth's Hospital: A woman, aged fifty-eight years, was admitted to the hospital on March 19, 1944, complaining of pain and the presence of a large lump in the left upper quadrant, of several months' duration. There were no symptoms referable to the urinary tract. She had experienced no urinary frequency, urgency, or painful urina-

worry over her boys in the Service. There was loss of appetite and she felt nauseated at times. The past history revealed no serious illnesses. The family history was irrelevant. She had had nine children, all of whom were living and well.

Physical examination revealed a grey-haired woman who appeared much older than her given age. Her appearance suggested the recent loss of weight. There was some pallor. The tongue was moist. There was a large, irregular, firm, slightly tender mass in the left quadrant, extending from the costal margin to just above the level of the anterior superior spine. It was believed to move on respiration. The right renal region was negative. On pelvic examination there was a healed laceration of the cervix and no masses could be felt in the vaults.

Laboratory findings: Blood: hemoglobin 68 per cent, white blood cells 9650, red blood cells 3,370,000.

Smear large polymorphonuclear cells 79, lymphocytes 21. Nonprotein nitrogen—26 mg. per 100 cc. of blood. Urine: Yellow, acid,

specific gravity 1010, albumin slight possible trace; sugar, none. Sediment: very many white blood cells, occasional epithelial cells. Culture:

was carried out, following which nephrectomy was performed.

Transperitoneal nephrectomy was done. The

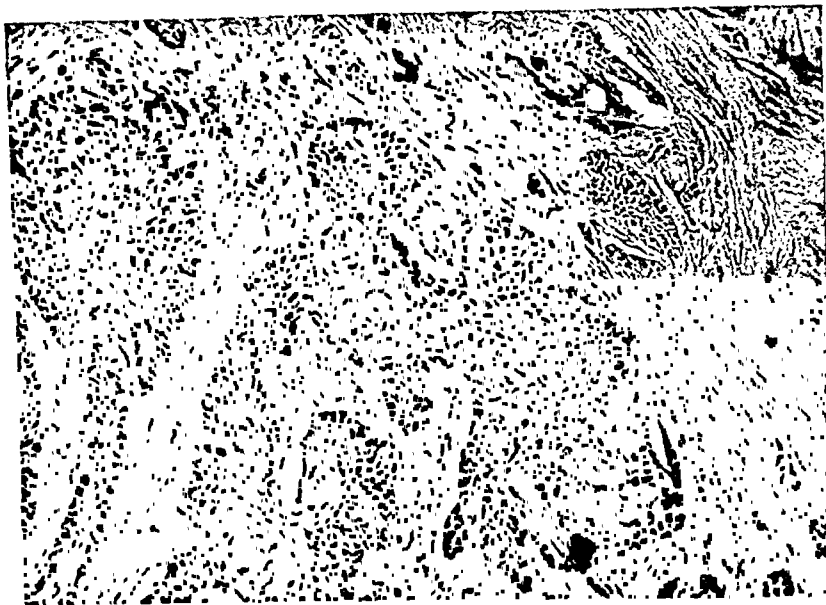


FIG. 2. Microphotograph showing epithelial pearls and intercellular bridges.

Bacillus coli. Right kidney urine: Sediment—a few epithelial cells. Culture: Bacillus coli. Phenolsulphonphthalein two-hour renal injection test: 5, 30, 13 and 5; total 53 per cent.

Cystoscopy revealed no urethral obstruction. The bladder tone, tolerance and capacity were normal. The mucosa was considerably injected throughout. There was a slight elevation of the trigone. The ureteral openings were normal. A No. 5 and a No. 4 F. ureteral catheter encountered impassable obstruction 2 cm. above the left orifice. A No. 5 F catheter was passed readily along the right ureter. A plain x-ray of the kidney, urethra and bladder revealed the presence of a peach-stone shaped shadow, consistent with calculus, in the lower left ureteral region and multiple large shadows in the region of the left kidney. The left renal shadow was enlarged. (Fig. 1.) An attempt to obtain a left ureteropyelogram was unsuccessful. A right ureteropyelogram revealed the ureter moderately dilated in the upper third, with some dilatation of the pelvis and calices. The kidney was in second degree ptosis.

A diagnosis of calculus, ureteral, left, and calculus pyonephrosis, left, was made. A general medical program, directed to the improvement of her general medical condition,

operative field was prepared with metaphen and alcohol. A left rectus paramedian incision was made, extending from the costal margin to just above the level of the anterior, superior spine through skin and fascia. The peritoneum was entered and a transverse incision carried laterally just above the level of the umbilicus. Palpation of the abdominal cavity revealed the presence of a large, firm, somewhat irregular, fixed, retroperitoneal mass. The bowel was reflected medially. The posterior peritoneum was adherent to the mass as was the pancreas, bowel, left ovary and the surrounding tissues. After considerable difficulty the adherent organs were separated from the tumor. The renal pedicle was then isolated, clamped, cut and the vessels were tied. The tumor was then freed from its bed. The ureter was markedly enlarged and was separated distally as far as possible, at which point it was clamped, cut and tied. The kidney and perirenal fat were then removed *en bloc*. It was necessary to remove the left ovary. Considerable bleeding was encountered and a lot of generalized oozing which was finally controlled. Two cigarette drains were left in the sound and brought out at the posterior angle of the lateral incision. The wound was closed with No. 1 chromic catgut and figure-of-eight stay

sutures. The sponge count was declared correct. The patient was given a blood transfusion during the operation and left the operating room in fair condition.

Pathological report: Received the left kidney with surrounding perinephric fat forming a large mass 23 by 19 by 11 cm. The kidney, 16 by 10 by 9 cm. is shelled out with great difficulty. The kidney is converted into a multilocular sac with large coral calculi filling many of the dilated calices. Only the shell of the cortex can be demonstrated. The pelvis is filled by a solid mass of tumor, pale, yellowish, and showing multiple focal areas of necrosis. The ureter is markedly dilated and thickened and has an average diameter of 3 cm. There is a purulent exudate throughout the pelvis and dilated calices. The perirenal fat is markedly thickened and there is direct extension of tumor from the pelvis. The average thickness is 3 to 4 cm.

Tissue from the pelvis shows invading neoplasm composed of masses of epithelial cells of the squamous type. Many onion bodies are demonstrated. Cells in places are necrotic, but those which stain well are fairly well differentiated and show deeply staining nuclei with occasional mitosis. Specimen from perirenal fat shows direct invasion by neoplasm. Tissue from lymphatic nodes shows similar invasion.

Diagnosis: Squamous cell carcinoma of renal pelvis with continuity extension to perirenal fat and surrounding lymph nodes; calculus pyelonephritis.

Postoperatively the patient's immediate condition was very satisfactory. There was some swelling and discoloration of the left lower extremity and it was believed that there had been some interference with the circulation due to manipulation of the blood vessels of the

pelvis. The extremity gradually improved, although she experienced considerable pain. Eight days after operation she suddenly developed severe dyspnea and chest pain and expired. No postmortem examination was obtained. It was believed that the terminal picture was due to a pulmonary embolus.

#### CONCLUSION

Non-papillary, squamous cell carcinoma of the renal pelvis is concisely discussed.

Its association with calculus disease of the kidney is emphasized. The medical profession should keep in mind the possibility of malignant disease within the kidney when renal calculi and infection are encountered in later life.

A case of non-papillary, squamous cell carcinoma of the renal pelvis associated with giant calculi of the kidney is presented.

#### REFERENCES

- SWIFT-JOLY, J. Tumors of the renal pelvis and ureter. *Brit. J. Urol.*, 5: 327, 1933.
- SCHOLL, A. J. Squamous cell tumor of the kidney associated with stone. *J. A. M. A.*, 100: 236, 1937.
- McMILLAN, S. F. and GILBERT, J. B. Squamous cell carcinoma of the renal pelvis with special reference to etiology. *Ann. Surg.*, 100: 429, 1934.
- SILVERSTONE, M. Squamous cell carcinoma of the renal pelvis. *Brit. J. Surg.*, 23: 332, 1935.
- NICHOLSON, W. F. Squamous cell carcinoma of the renal pelvis. *Brit. J. Surg.*, 24: 397, 1936.
- PRIESTLEY, J. B. Non-papillary epithelioma of the renal pelvis. *J. Urol.*, 33: 674, 1937.
- HIGGINS, C. C. Squamous cell carcinoma of the renal pelvis. *Arch. Surg.*, 38: 224, 1939.
- MELICOW, M. M. Classification of renal neoplasms. *J. Urol.*, 51: 333, 1944.
- KRETSCHMER, H. L. Primary non-papillary carcinoma of the renal pelvis. *Arch. Surg.*, 38: 224, 1939.



# MEGACOLON\*

## WITH A BRIEF REVIEW OF ETIOLOGICAL FACTORS AND TREATMENT

HUGH A. BAILEY, M.D.

AND

JOSEF J. HABER, M.D.

Associate Chief Surgeon, Charleston General Hospital

Chief Surgical Resident, Charleston General Hospital

CHARLESTON, WEST VIRGINIA

THE etiology of megacolon or Hirschsprung's disease has been frequently discussed but to date no completely satisfactory solution has been found. To find the proper theoretical background in dealing with this problem is not only of academic value but is of great practical importance. The etiology should determine the type of treatment to be chosen.

There are two main schools of thought, one teaching that megacolon is a sequence of some type of congenital obstruction, the other declaring that it is based on a congenital anomalous development. The first group supports its theory by the findings of torsion of sigmoid, atresia of the anal canal, rectum or sigmoid, partial imperforate anus, hypertrophied rectal valves, etc. The second group believes that Hirschsprung's disease is congenital in origin with congenital hypertrophy and dilatation of the affected part of the colon, and classifies all cases of acquired megacolon as secondary or pseudomegacolon.

Many such cases of megacolon were reported to have originated during the first few days after birth and some during late fetal life. However, other patients with congenital obstructive anomalies such as imperforate anus, anorectal strictures and the like, did not show signs of megacolon.

The present belief is that true megacolon or Hirschsprung's disease is congenital and neurogenic in origin. It is a "dysfunction of the neuromuscular mechanism" (Adson) with either a hyperactivity of

the sympathetic nervous system or a hypoactivity of the parasympathetic system.

The primary cause of this "dysfunction" or "neuromuscular incoordination," as called by Wade, has never been satisfactorily explained by any of these who have written on this subject.

The circular muscle fibers of the rectum are innervated by the sympathicus which, according to Hunter and Royle, is the causative factor for contraction of the sphincter and the maintaining of its normal tonus. Any irritating lesion of the sympathicus, peripheral or central, this means postganglionic or preganglionic, may cause a spastic condition of the rectal sphincter with failure to relax (Hurst, Fraser) and thus creates a basis for the development of megacolon.

After considering the above mentioned theories explaining the etiology of megacolon, we will be able to understand the different types of treatment advised and used for this condition. The medical treatment of megacolon as shown by a review of the literature, is not nearly so effective as the surgical, and probably should be reserved for use in very mild cases or as a preoperative preparatory procedure.

In the following recent statistical review of the literature in connection with 512 cases of megacolon, reported by Duval, Lowenstein, Terry, Neugebauer, Ladd, Judd, Adson, Wade, Royle and Rankin, the relation between medical and surgical treatment is clearly brought out.

\* From the Department of Surgery, Charleston General Hospital. This case is being reported for the following reasons: (1) A very close and thorough study and follow-up for a considerable length of time could be carried out; (2) in reviewing the literature the authors found only comparatively few cases of megacolon reported, treated by sympathectomy.

In the report of 252 patients treated medically, the mortality ranged from 66 to 98 per cent with cures ranging from

by sympathectomy (Wade, Judd, Adson, Rankin, our case report included) only one death occurred; this followed an attack

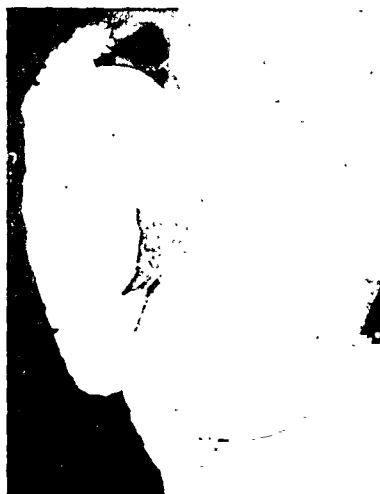


FIG. 1. Barium enema on September 30, 1942, reveals dilatation of the transverse, descending and sigmoid colon due to a megacolon.



FIG. 2. The evacuation film reveals that the patient was unable to pass any of the enema.



FIG. 3. Barium enema on June 5, 1944, reveals moderate dilatation of the transverse, descending and sigmoid colon. Rhythmical peristaltic waves were seen throughout the large bowel.



FIG. 4. The evacuation film reveals patient was able to pass about three-quarters of the contained barium. There is a moderate amount of air remaining in the large bowel.

2 to 12 per cent. Two hundred thirty-eight patients treated surgically (including all operative procedures other than sympathectomy) reveal a mortality of 26 to 48 per cent and a cure rate of 34 to 74 per cent.

Among the twenty-two patients treated

of pneumonia, occurring two months after operation. Except for two cases, all post-operative results have been reported as satisfactory.

Different types of operations have been described and used with more or less success in the treatment of Hirschsprung's

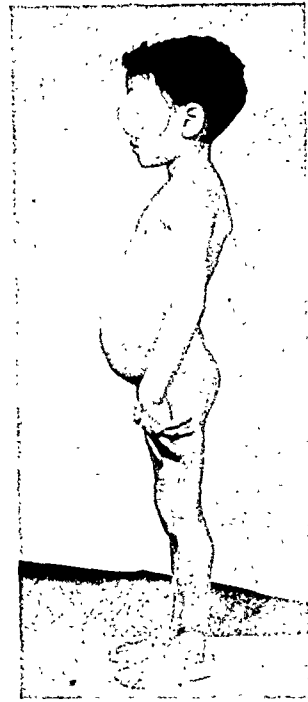
disease. Plastic operations, plication of the colon, short circuiting procedures, most of them have been found to be inadequate and probably possess only historical value at the present time. Radical resection of the diseased colon was for some time the operation of choice and is still being successfully used in selected cases. The operative risk is rather great, usually 25 per cent mortality or more in the hands of the best surgeons, with recurrences not infrequent.

Medical Treatment, 252 cases	Per Cent
Mortality.....	66 to 98
Cures or improvement.....	2 to 12
Surgical Treatment Other than Sympathectomy, 238 Cases	
Mortality.....	26 to 48
Cures or improvement.....	34 to 79
Sympathectomy, 22 Cases	
Mortality.....	4.5
Cures or improvement.....	90

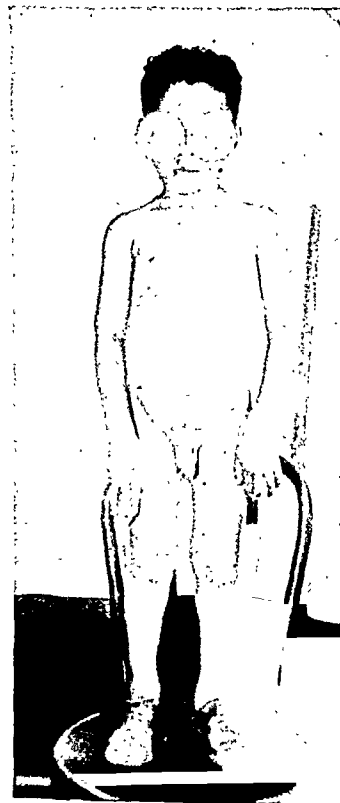
Having the previously mentioned etiological factors in mind, it would appear that in cases of acquired megacolon, in which primary obstructive causes may be present, radical resection of the diseased part of the colon is probably a logical and successful procedure. But in all cases in which there is apparent dysfunction of the neuromuscular mechanism, an operation for the correction of this condition should be the treatment of choice. The mortality rate for this type of operation is almost negligible, also excessive morbidity and prolonged hospitalization are markedly decreased.

The following operative procedures are all based on the same principle, that of eliminating the excessive stimuli of the sympathetic nervous system in the involved portion of the colon, and perhaps, thereby creating a condition of relative overstimulation of the parasympathetic innervation.

The removal of the first and second lumbar ganglia on the left as advocated by Wade, seems to be successful in moderately severe cases. The resection of the inferior mesenteric nerves in conjunction with resection of the presacral nerve has given



A



B

FIG. 5. A, side view; B, front view of patient showing still some moderate enlargement of the abdomen about one year after operation.

good results, as reported by Rankin and Learmonth. Bilateral sympathetic ganglionectomy, including the resection of the intervening trunk is practiced successfully by Adson and Judd.

There are too few reported cases of megacolon treated by sympathectomy to enable us to arrive at final conclusions. It can be stated that most of the reported cases showed considerable postoperative clinical improvement. Distention and dilatation of the abdomen in some cases were only slight, and in others were not relieved.

#### CASE REPORT

Ch. C. A., a three year old colored boy, was admitted to the pediatric department of the Charleston General Hospital September 29, 1942, with the complaints of constipation, and enlargement and distention of the abdomen.

The mother stated that since birth the patient had never had a normal bowel movement and that occasionally he was unable to evacuate his bowels for several days and sometimes as long as a week, in spite of cathartics and enemas. The patient had required laxatives all of his life, large doses frequently being necessary. The stools were usually firm. His abdomen had always been large and apparently distended with gas. His condition had gradually become worse. He had not had a satisfactory bowel movement during the last two weeks. There was no vomiting but occasional nausea. His appetite was only fair. This child became listless and inactive recently and the mother was very much concerned about his general welfare and was very anxious that something be done to improve the boy's condition.

Examination on admission revealed that the patient was fairly well developed for his age and fairly well nourished, lying in bed inactively, but without signs of acute distress. His temperature was 99.4°F.; the skin was rather dry. The outstanding feature was marked enlargement of the abdomen, moderate distention over the entire abdomen; there were areas of dullness in the lower part of the abdomen probably due to fecal impaction. The intercostal angles were somewhat wide and obtuse, apparently the result of increased intra-abdominal pressure.

Clinical laboratory findings were as follows: Kline exclusion test negative; urinalysis:

specific gravity 1.001; reaction acid; sugar and albumin negative; 2 to 3 pus cells per field. Blood picture: hemoglobin 50 per cent; erythrocytes 3,800,000; leucocytes 10,600; color index 0.6; lymphocytes 31 per cent; monocytes 2 per cent; neutrophils, stabs 5 per cent; neutrophils, segments 52 per cent and eosinophils 10 per cent.

Stool examination for ova and parasites was negative. Stool culture showed *Faecalis alcaligenes*.

Roentgenograms were made September 30, 1942. A barium enema revealed a moderate dilatation of the transverse, descending and sigmoid colon due to megacolon. No peristaltic waves were visualized under fluoroscopic examination. The evacuation film revealed that the patient was unable to pass any of the enema. It was obvious that this child was suffering from congenital idiopathic dilatation of the colon.

For more than three weeks, this patient was treated by dietary management (low residue diet) with daily enemas and mineral oil by mouth and as a retention enema with only fair results. It was believed that surgical treatment might improve the patient's condition.

As the disorder was entirely left-sided, unilateral lumbar sympathetic ganglionectomy was proposed. After several small blood transfusions had been given this patient underwent operation on October 23, 1942, at which time a left sympathetic ganglionectomy was performed by one of us (H.A.B.), resecting the second, third and fourth lumbar ganglia by transperitoneal Adson approach. The resected ganglia and rami did not show any pathological changes.

The abdomen was entered by way of a left paramedian incision. The splenic flexure of the transverse colon, descending colon and sigmoid showed the true picture of megacolon—marked dilatation and hypertrophy of the intestinal wall. A large amount of fecal material could be palpated in the distended part of the colon. Only sluggish peristalsis could be observed. The rest of the colon and small bowel were about normal in appearance. There were no findings indicating any obstructive lesion.

The postoperative course was uneventful. The temperature rose on the first postoperative day to 101°F., rectally and came down to normal the next day and remained so for the remainder of the patient's stay in the hospital.

The temperature of the left leg compared with that of the right was markedly increased. On the second postoperative day the patient was put on a diet for age as tolerated and small saline enemas were given daily with prompt results. The enemas were gradually discontinued and mineral oil then given by mouth.

Within a few days after operation, a marked change could be noticed in the general appearance of the patient. He became interested in his surroundings, was active and his appetite improved. He was discharged on November 11, 1942, and his mother advised to bring him in monthly for check-up.

The mother was very cooperative and lived near the hospital, so that frequent observations of this patient could be made. During the patient's following visits to the hospital general improvement could be noticed. The mother stated that the child was doing nicely and that his general condition was much better than before the operation. She stated that enemas were no longer necessary to secure bowel movements but that it was necessary to give him mineral oil almost daily for the first few months following operation.

The last time this child was seen, June 15, 1944, more than one and one-half years after operation, the abdomen was still moderately enlarged but otherwise he seemed to be quite well. X-ray studies done at this time revealed: "A moderate dilatation of the transverse, descending and sigmoid colon. There were definite peristaltic waves visualized at the time of the fluoroscopic examination. An x-ray study taken after evacuation indicated that the patient was able to pass about three-fourths of the barium enema. There was a moderate amount of air remaining in the large bowel."

#### CONCLUSIONS

1. A brief review has been made of the different etiological factors and types of treatment of megacolon.

2. It was noted that marked clinical improvement followed different types of sympathectomy.

3. Sympathectomy involves comparatively little operative risk, and as the statistical review indicates, shows a very low postoperative mortality.

4. The case of a patient with megacolon successfully treated by unilateral lumbar ganglionectomy is reported.

#### REFERENCES

1. ADSON, ALFRED W. Hirschsprung's disease: report of cases in which relief was obtained by sympathectomy. *Proc. Inter. Postgraduate Medical Assembly of North America*, p. 114, 1933.
2. BARTLE, HENRY J. Megacolon: a resume of the literature and report of a case, ramisection proposed as a form of treatment. *Am. J. Med. Sc.*, 171: 67, 1926.
3. JOHNSON, PEER P. Megacolon in the adult with report of two cases. *Boston M. & Surg. J.*, p. 88, January, 1921.
4. GRAVES, STUART, M. D. Congenital idiopathic dilatation of the colon or Hirschsprung's disease. *Ann. Surg.*, p. 734, June, 1918.
5. JUDD, E. S. and ADSON, A. W. Lumbar sympathetic ganglionectomy and ramisection for congenital idiopathic dilatation of the colon. *Ann. Surg.*, 88: 479, 1928.
6. HERR, HARRY H. Radical treatment of Hirschsprung's disease. *South. M. J.*, 18: 290, 1925.
7. LADD, W. E. Megacolon. *Boston M. & Surg. J.*, p. 81, January, 1921.
8. RANKIN, FRED W. and LEARMONTH, JAMES R. Section of the sympathetic nerves of the distal part of the colon and the rectum in the treatment of Hirschsprung's disease and certain types of constipation. *Ann. Surg.*, 92: 710, 1930.
9. RIVER, LOUIS P. and GUBLER, JOHN A. Transverse megacolon associated with chronic volvulus. *Ann. Surg.*, 117: 786, 1943.
10. WADE, R. B. and ROYLE, NORMAN D. The operative treatment of Hirschsprung's disease—a new method. *M. J. Australia*, 1: 137, 1927.
11. WADE, R. B. Left lumbar ramisection in Hirschsprung's disease. *Lancet*, 1: 136, 1930.
12. LEARMONTH, J. R. and MARKOWITZ, J. Studies on the function of the lumbar sympathetic outflow. The relation of the lumbar sympathetic outflow to the sphincter ani internus. *Am. J. Physiol.*, 89: 686-691, 1929.





# BLADDER HERNIATION AND KIDNEY STONE

CHANNING W. BARRETT, M.D.

At present on Augustana Hospital Staff;  
Formerly Attending Gynecologist,  
Cook County Hospital

AND

RUSSELL A. BARRETT, M.D.

Formerly Associate Gynecologist,  
Cook County Hospital

CHICAGO, ILLINOIS

THE points in the following case which we think worth while emphasizing are:

1. The original vaginal hysterectomy for "uterine prolapse" instead of a thorough hernioplastic rebuilding for injured pelvic floor with extensive herniation, does not accord with the alleged findings. We find that vaginal and abdominal hysterectomy as a single operation is performed erroneously for these extensive herniations, and it seems apparent that it is a result of the faulty nomenclature of "prolapse of the uterus." One of us (C.B.) published a paper on the hernial nature of these conditions (*Am. J. Obst.*, 1909).

2. It seems worth while to again call attention to the two distinct portions of the bladder, one part still in the abdomen and unharmed, and one part herniated and suffering from circulatory disturbances. This is easily a prey to infection and is constricted by the pelvic floor ring, making of the bladder in many cases an hour-glass structure.

3. A technic of vaginal vault attachment with vaginal and fascial narrowing and substantial pelvic floor rebuilding is shown to restore these structures to position, even in those cases in which there is marked herniation after hysterectomy when there has been no vaginal attachment or pelvic floor hernioplastic repair. This to us seems preferable to vaginal obliteration.

4. This case, with infection, engorged lymphatics, obstructed circulation, edema, infected and choked urinary tract, degeneration of tissue, with epithelial change, illustrates the desirability of preliminary preparatory treatment, with rest in bed,

and retention of herniated structures in the pelvis by the Sims position, and slight Trendlenburg position and tampons, so that edema and infection will subside, circulation and tissue degeneration will improve and the bowels and urinary tract be disengorged.

5. In this case on account of the kidney pelvis containing pus, a half sitting posture should be assumed for a short time several times a day.

6. We fear that repeated kidney catheterization with irrigations may do more harm than good.

7. Such extensive infection is most unfortunate and should not occur often.

8. One of the chief values of this report is to emphasize again the hernial nature of the condition to be overcome.

## CASE REPORT

There came under our observation a Mrs. A., age sixty-five, whose case presents some unusual points and emphasizes facts not usually accepted, which should receive more general recognition. She was an overweight woman, appearing very sick, a bedridden patient, who seemed without hope of recovery. It was rather difficult to persuade her that treatment of a surgical nature was worth while, as she had been told repeatedly that nothing could be done.

The patient presented a history of long standing pelvic floor herniation, for which she had been operated upon for "prolapse of the uterus" two years previously. The condition according to description was a rather extensive herniation of the bladder and uterus, with some involvement of the rectum. The operation had been chosen according to the nomenclature of "prolapse of the uterus" and nothing was done to replace or retain the remaining herniating organs in the abdomen. Unfortu-

nately, a very severe suppurative process followed the vaginal hysterectomy, which process involved the vagina, intrapelvic structures and the bladder. The patient reported a very severe inflammation of the vulva and area around the rectum as well. During this sickness she had chills and severe pain in the left part of the abdomen and in the lumbar region, indicating a probable pyelitis.

From these conditions the patient continued to suffer for the two years following the operation, until coming under the care of one of us (R.B.). She then complained of severe headache and severe colicky pains, with swelling, and of urine containing pus and blood. The large part of the vagina and bladder were protruding and were accompanied by a smaller portion of the rectum, all of which were smeared with a constant foul discharge. An incontinence of urine was present. She had spent most of the two years in bed.

The patient was seen in consultation by us after some improvement had resulted from douches and efforts to keep the herniations reduced. As they had to make some arrangements, it was decided that this treatment should be continued until she could be gotten in the hospital, when bladder irrigations should be added, and a cystoscopic, ureteral and kidney study should be made. A tentative diagnosis of bladder, vaginal and rectal herniation through the pelvic floor, a marked cystitis, and ascending ureteritis, pyelitis, pyonephrosis and probable kidney stone were present.

She entered the Augustana Hospital, January 28, 1944, and underwent observation and preparatory treatment. Cystoscopic and ureteral study by Dr. Scully revealed a bladder

with findings of severe trabecular cystitis in the portion of bladder protruding from the pelvis and a normal bladder mucosa lining the portion of the bladder within the abdominopelvic cavity, not only verifying the hernia, but showing the damaging effects of the herniation upon the bladder wall. The ureteral openings were located but no fluid was found spurting from the left ureter. The right ureter was spurting at regular intervals, a rather cloudy urine, and ureter and kidney pelvis were found normal. An x-ray study by Dr. Beilin found a normal right kidney, but a decidedly enlarged left kidney with a cloudy shadow, suggesting stone.

The patient was subjected to left nephrectomy on February 9, 1944. The kidney was found large and contained an irregular stone surrounded by bloody pus. She made a good recovery and went home for recuperation treatment February 24, 1944. She returned March 12th for a hernioplastic repair for the pelvic floor hernia March 13, 1944.

The anterior vaginal wall was laid open and the redundant vaginal and bladder fascias were reduced in size, and a portion of anterior vaginal wall removed. The posterior cul-de-sac was opened and the broad ligament stumps were recovered and sewed to the vaginal vault and sides. The posterior vaginal flap was then raised and a very thorough hernioplastic reconstruction was done upon the muscles and fascias of the pelvic floor, making the pelvic floor somewhat more closed than in the normal condition. The patient now reports normal bladder retention, absence of protrusion and freedom from abdominal and lumbar pain.



# SUPRAVESICAL INTERNAL HERNIA\*

WENDELL DOWNING, M.D.

On Surgical Staff, Sacred Heart Hospital

LE MARS, IOWA

INTERNAL hernias as a cause of acute intestinal obstruction are rare surgical conditions. When the obstruction is caused by an internal supravescical hernia, it is even more unusual. In 1940, Warvi and Orr<sup>1</sup> in an exhaustive study of the literature found reports of thirty-seven cases with findings definite enough to be classified as internal supravescical hernia. Twenty-eight of these cases of supravescical hernia were of the prevesical type. In all the authors found twenty-two names had been used to identify this unusual hernia, thus making classification difficult. Stalker and Gray<sup>2</sup> in 1939 reported twenty-nine cases of internal hernia seen at the Mayo Clinic since 1910, only one of which was of the supravescical type. In addition to the twenty-eight cases reported by Warvi and Orr two more cases of prevesical hernia have since been reported in the literature.<sup>3,4</sup>

Supravescical hernias develop in the supravescical space which is bounded by the lateral umbilical folds (obliterated hypogastric arteries), the pubis and the peritoneal reflection over the bladder. This space is also divided into right and left halves by the remnant of the urachus. A hernia into the supravescical space may appear externally (a more common type), the hernia presenting in the inguinal, femoral and obturator areas. The more rare internal type may be prevesical (space of Retzius), paravesical (lateral) or intravesical. The exact cause of a supravescical hernia is not understood but a diverticulum first forms into which a loop of intestine becomes engaged with resulting strangulation.

The author recently encountered a case of acute intestinal obstruction caused by a strangulated prevesical hernia. This was

the second strangulated internal hernia seen in our small hospital in twenty-four years, the other being the result of a herniation through the broad ligament (postoperative).

## CASE REPORT

Mr. T. J., age sixty-seven years, was admitted to the hospital at 10 P.M. February 5, 1944. His past history was negative for serious illness and injury and he had had no previous abdominal symptoms. At 11 A.M. February 2nd, while standing at a farm sale the patient developed sudden colicky abdominal pain followed by vomiting. His pain was periodic but mild and he vomited infrequently. He had normal stools the first day but none thereafter and no flatus was expelled. Two hours before admission he was seen by his physician, Dr. L. I. R. Hegg, of Rock Valley, Iowa, who referred him to the hospital with a diagnosis of acute intestinal obstruction.

On admission the patient's general condition was good; temperature, pulse and respirations were normal and his attacks of pain were infrequent and not severe. He showed definite dehydration and moderate abdominal distention. There was some tenderness to the left of the umbilicus but no mass was palpable. Peristalsis was active. No external hernia was present and a rectal examination was negative. No bladder symptoms were present. The white blood count was 9,000 and the urine was normal. During the night the patient was treated by intravenous fluids and gastric suction and one hypodermic of morphine was given. By morning the dehydration was decreased and x-ray examination of the abdomen showed dilated loops of small intestine with fluid levels. A barium enema showed a normal colon. A diagnosis of mechanical intestinal obstruction from an undetermined cause was made.

Twelve hours after admission the patient's abdomen was explored through a left para-

\* From Le Mars Clinic, Le Mars, Iowa.

median incision below the umbilicus. The peritoneal cavity contained serosanguineous fluid, several loops of dilated small intestine were present and a loop of small intestine was herniated into the supravescical space just to the right of the midline. The scarred neck of the sac was incised and a loop of small intestine 5 to 6 inches in length was delivered. Circular pressure areas were present but the strangulated loop was not gangrenous. The neck of the peritoneal sac admitted two fingers; the diverticulum was four inches deep and extended into the prevesical space, the peritoneal lining being adherent to the prevesical fat. The neck of the sac was further scarified and was closed by cotton sutures. Proximally, several loops of small intestine were adherent to each other by fine fibrous non-obstructing adhesions. The incision was closed and the patient treated by gastric suction and intravenous fluids. He made an uneventful recovery and was dismissed from the hospital on the twelfth post-operative day.

A correct preoperative diagnosis of supravescical hernia has been made only

once, Fromme, in 1908, making a correct diagnosis by clinical and cystoscopic findings. In a given case of acute intestinal obstruction one might make a correct diagnosis if the patient had no apparent cause for the obstruction but had suprapubic tenderness, urinary frequency and compression of the bladder fundus as seen on cystoscopy. In treating a supravescical hernia removal of the adherent peritoneal sac is not necessary; scarification of the neck of the sac and simple closure seem sufficient. The mortality in the cases reported in the literature was high due to the strangulating obstruction.

#### REFERENCES

1. WARVI, W. N. and ORR, T. G. Internal supravescical hernias. *Surgery*, 8: 312-325, 1940.
2. STALKER, L. K. and GRAY H. K. Prevesical hernia: report of case. *Proc. Staff Meet., Mayo Clin.*, 14: 321-324,
3. WAKELEY, C. P. G. Case of prevesical hernia. *Med. Press*, 203:, 37-38,
4. BERSON, H. L. Prevesical hernia. *Am. J. Surg.*, 59: 123-125, 1943.



# PENDULOUS ABDOMEN

## ITS SURGICAL CORRECTION

A. SAMPOLINSKI, M.D.

Associate Clinical Professor of Surgery, Loyola University; Senior Surgeon, St. Mary of Nazareth Hospital  
CHICAGO, ILLINOIS

**A** PENDULOUS ABDOMEN is not uncommon among female patients. It is not unusual to find a lipomatous apron in obese persons extending down to the upper thigh region and interfering with the individual's gait. This is

constituting the subject of this paper make this case report unusual.

### CASE REPORT

During the course of the first interview with this patient, it was learned that the onset of

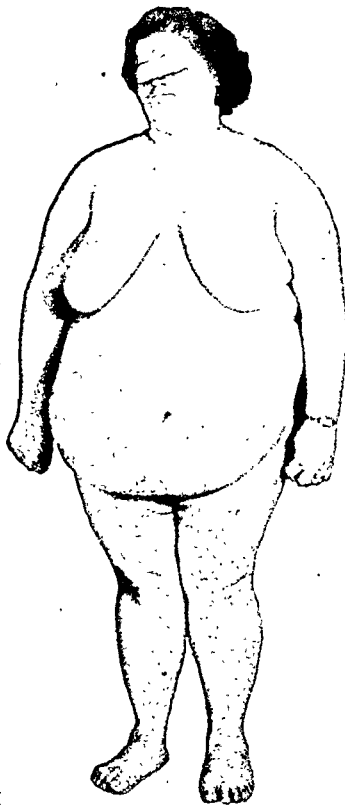


FIG. 1. Front view of patient before operation.



FIG. 2. Side view of patient before operation; note the size of supported abdominal fold.

particularly true of female patients who resort to various types of corsets and foundation garments for postural support. The extreme obesity and the excessive pendulous abdominal fold in the patient

her menses took place when she was seventeen and one-half years old. They were always irregular, of a sixty to ninety day interval, and had not occurred since the time of her

operation three years previously. She had never been pregnant and as far as she could remember, she was inclined to be overweight.

Her recent gain, however, amounted to nearly 100 pounds. Her general health, nevertheless, was good and she took pride in her strength and endurance. Despite this patient's evident glandular dyscrasia, the family situation made resort to surgery of the character of an emergency. The patient was informed of the risks and prognosis of an operation of this type, but under the pressure of home circumstances, she made light of them and insisted on immediate operation.

Following a pelvic operation three years previously, this twenty-six year old woman gained weight rapidly. She was 61 inches tall and weighed 265 pounds. Most of her increase

A voluminous right-sided incisional hernia aggravated her distress.

The patient was sensitive of her appearance



FIG. 3. Elliptical fold removed at operation; weight sixty-four pounds.

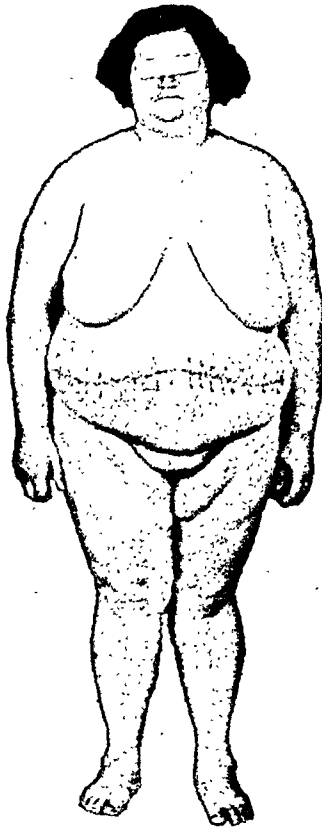


FIG. 4. Front view of patient four weeks after operation.

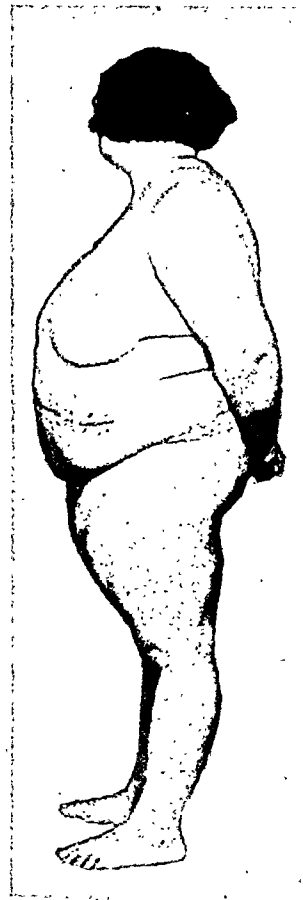


FIG. 5. Side view of patient four weeks after operation.

in weight seemed to occur about her abdomen which progressively became pendant, the fold hanging to within 7 inches of her knees when she was in a standing position. (Figs. 1 and 2.)

and unhappy because her marital relations became strained, her husband threatening divorce proceedings unless steps were taken

to correct her uncomely condition. Rigid dietary restrictions appeared to have little influence on the upward trend of her weight.

Under ethylene oxide-oxygen anesthesia an elliptical incision extending 7 inches above and 9 inches below the umbilicus was made, the two apices reaching laterally to the crest of each ilium. The incision extended through 5 inches of fatty tissue before exposing the anterior abdominal fascia.

All scar tissue was resected, as was the hernial sac. The hernial defect in the abdominal wall measured 4 inches in diameter. This latter was closed by a modified Mayo operation technic, drawing one flap under the other and anchoring both with a double mattress suture. The skin margins were approximated by means of interrupted dermal reinforced with six silk-worm tension sutures.

The removed elliptical skin and subcutaneous lipomatous fold measured 16 by 21 inches, and weighed 64 pounds. (Fig. 3.)

The postoperative course was uneventful, the sutures were removed on the tenth day, and the patient was discharged from the hospital on the fourteenth day after operation.

Under a balanced, restricted dietary regimen and glandular therapy, the patient's weight three months after operation appeared controlled, there being no appreciable increase over the recorded weight noted on the day of hospital discharge.

The physical results in this patient (Figs. 4 and 5) can be measured only by the mental improvement, the eased marital relations, and the general sense of well being. The patient was sincere in the gratitude expressed that her home was not disrupted.



INJURED nerves may be anatomically or physiologically interrupted. Davis states that there is no way by which complete anatomical or physiological interruption can be differentiated. If there is doubt about complete or partial anatomical division of a nerve, operation may be postponed for four to six months to await evidence of nerve regeneration.

From "Operations of General Surgery" by Thomas G. Orr (W. B. Saunders Company).

# MULTIPLE PRIMARY MALIGNANCY

CHARLES GOLDMAN, M.D.

Associate Surgeon, Brooklyn Cancer Institute

BROOKLYN, NEW YORK

**B**ILLROTH formulated the following requirements which he considered necessary to make a diagnosis of multiple primary malignancy: (1) Each tumor must have an independent histologic primary appearance; (2) the tumors must arise in different situations, and (3) each tumor must produce its own metastasis. The first two requirements seem reasonable, while the third does not always occur in single primary malignancy, notably adenocarcinoma of the fundus of the uterus.

The criteria of Goetze for a diagnosis of multiple primary malignancy seem more reasonable: (1) The tumors must have the macroscopic and microscopic appearance of the usual carcinomas of the organs involved; (2) exclusion of metastasis must be certain, and (3) diagnosis, in each case, may be confirmed by the character of the individual metastasis.

Warren and Gates criteria for a diagnosis of multiple primary carcinoma seem most reasonable, and, to us, sufficient for such a diagnosis: (1) The tumor must present a definite picture of malignancy; (2) each must be distinct, and (3) the probability of one being a metastasis of the other must be excluded.

As Portuonda says, in his report of a case of three primary malignancies, "Thus while Billroth makes the production of metastasis—an accidental occurrence—one of the essentials, Warren and Gates stress only the intrinsic characteristics of the neoplasm."

We shall not concern ourselves with the question whether the occurrence of multiple primary malignancy is mere coincidence or is an example of tumor diathesis. This case report may be added to those cases of multiple primary malignancy already

reported and may serve as a source of speculation for those interested in this side of the question. A fairly careful search of the literature revealed no case of four primary malignancies in one patient; and, although there may be no scientific significance to the occurrence of multiple primary malignancies, this case should be of interest.

## CASE REPORT

I. S., aged sixty years, a housewife, was admitted to the Brooklyn Cancer Institute, May 26, 1941. Her chief complaint was cramps in the lower abdomen, for the past year. She said that she had run a temperature since May 1, 1941. Her father died at seventy; mother died at sixty-five years. The patient said they died of old age. Cardiac, diabetic, or tumoral history in the family was denied; there was no history of tuberculosis.

The patient did not remember any childhood diseases. Menstruation began at thirteen years and was regular. She was a para III, gravida III, and was married at twenty years of age. Her surgical history included removal of the left breast in 1922, at Mt. Sinai Hospital, New York; removal of ribs in October, 1939; removal of chest nodule March, 1941, at Mt. Sinai Hospital, New York; dilatation, curettage and x-ray therapy for cancer of the cervix in April, 1940, at the Memorial Hospital, New York. The patient denied any signs or knowledge of venereal disease. There was a loss of ten pounds during the year, and complaint of muscular and joint pains.

During the past year the patient had frequent abdominal pains. Since May 1, 1941, there was vaginal spotting, associated with pain over the left kidney, and nocturia.

The patient appeared to be about sixty years old, fairly well nourished, who showed signs of recent weight loss. Her eyes reacted to light and accommodation. There was no pathological condition of the ears, nose, throat, or teeth. The tongue was glossy and red. The



mucous membrane of the angle of the mouth showed signs of B<sub>2</sub> deficiency. No glands could be palpated in the neck. There was an old

vaginal introitus was snug. A firm mass was felt at the left, filling the cul-de-sac, extending three inches above the symphysis. A tumor

FIG. 1.

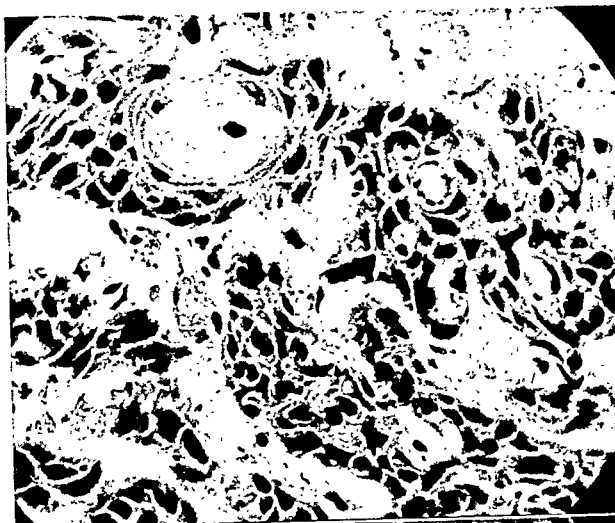


FIG. 2.

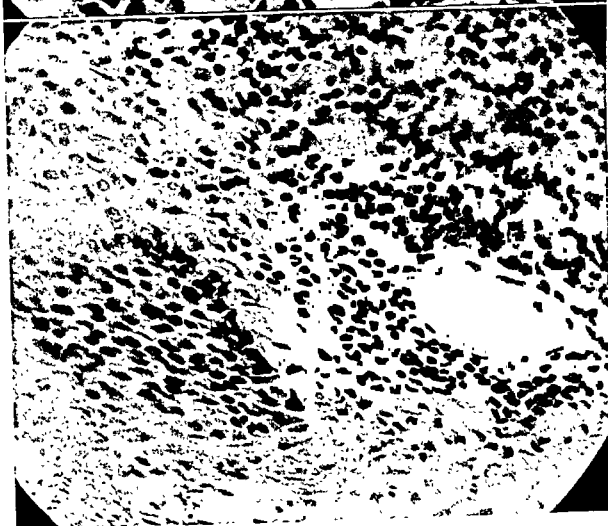


FIG. 1. Post-radiation epidermoid carcinoma (squamous cell type).

FIG. 2. Recurrent nodule in scar of chest wall (squamous cell type).

mastectomy scar on the left side of the chest, and there was absence of the fourth, fifth, and sixth ribs on the left side. There was a pre-systolic murmur present, the heart sounds were of good quality, and the apex beat was visible. The blood pressure was 127/75. No dullness was detected in the lungs. Somewhat feeble breath sounds were elicited over the right lung field. The abdomen was pendulous, soft and not distended. There were no signs of venous distention, nor abdominal tenderness. The liver and spleen could not be palpated. There was pain over the left kidney region. The

about the size of a walnut, which was painful to the touch, could be felt in the rectum. No glands could be felt in the groin. There was no pathological condition of the extremities, and all reflexes were present.

Examination on May 28, 1941, showed that the patient had a cancer of the cervix, treated at the Memorial Hospital, New York, with radium and x-ray therapy. Admission diagnosis was acute pyelonephritis. Pelvic examination revealed a contraction of the vault of the vagina; the cervix was not palpable. Rectal examination revealed a hard, solid, fixed mass

3 inches from the anus. The greatest extent of the mass appeared anteriorly.

At the genitourinary examination a No. 24

wall of the rectum. This mass was hard and irregular and appeared to be somewhat movable. The tip of the examining finger could be

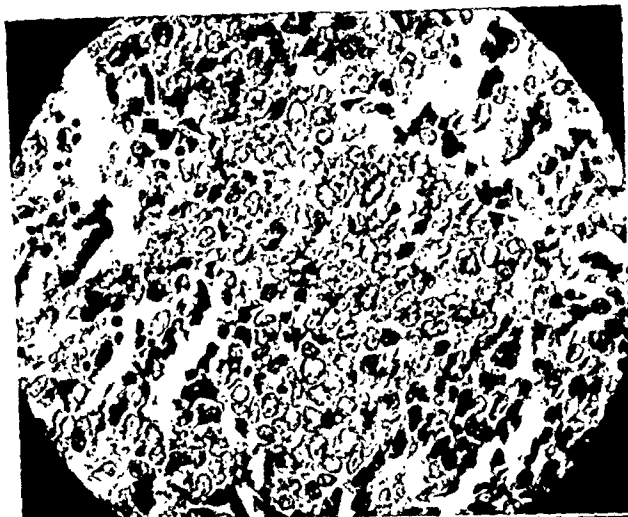


FIG. 3.

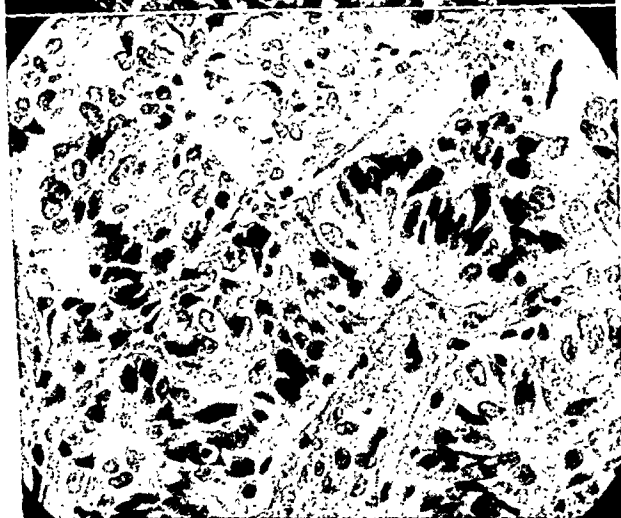


FIG. 4.

FIG. 3. Epidermoid carcinoma of cervix (transitional cell type).

FIG. 4. Papillary adenocarcinoma of rectal origin.

scope was easily introduced. No neoplasm or calculi were noted. The mucosa appeared normal; a turbid bladder urine was present; the bladder capacity was normal and the orifices were in the usual locations. The left ureter was catheterized without obstruction and clear urine was obtained. On the right side, there was an obstruction at the ureteropelvic junction and the urine was turbid. Indigo carmine was injected; a return occurred from the right side in eight minutes, with fair concentration, and from the left side in six minutes, with fair concentration.

Digital examination revealed a cauliflower mass arising from the anterior and left lateral

passed over the summit of the mass, which was 4 inches above the anus. The mass was grayish red and friable. The scope was passed beyond this mass, but no other pathological condition was found.

On June 4, 1941, after intravenous pyelogram, both kidneys appeared normal in size, shape and position. The right kidney functioned poorly, the left kidney more poorly. The right pyelogram was normal, the left showed moderate hydronephrosis. The bladder was completely filled. X-ray examination, on June 6, 1941, after retrograde pyelogram revealed that both ureter catheters ascended as far as the renal pelves. The right pyelogram

and ureterogram were very slightly dilated, apparently within normal limits. The left pyelogram showed moderate hydronephrosis.

A letter received from the Mount Sinai Hospital, New York City, dated June 16, 1941, contained the following information:

Patient I. S. Summary: Nineteen years ago (1922), Dr. Howard Lilienthal performed a left radical mastectomy for medullary carcinoma. This was followed by radiation. The patient was admitted to the Mt. Sinai Hospital again October 2, 1939. In the midst of the scar, a small ulcerative lesion began and this had increased slowly in size. At operation, by Dr. Harold Neuhof, the cage about the ulcer was freed and excised down to, and including, the pleura. In order to close the defect the opposite breast was freely mobilized by the appropriate incision and sutured over. The patient made an uneventful convalescence and the wound healed by primary union, except for a small area far removed from the site of plastic closure. Date of discharge was October 27, 1939.

In view of the pathological examination revealing squamous cell carcinoma, the assumption of radiation as the cause of the lesion had been warranted.

The patient was again readmitted March 4, 1941, for the removal of a nodule of the chest wall, which was a recurrent squamous cell carcinoma. The patient was discharged the same day.

Unfortunately the slide of the medullary carcinoma of the breast was lost from the files of the Mt. Sinai Hospital. Figures 1 and 2 show the post-radiation squamous cell carcinoma and the recurrence in the chest wall.

The section examined microscopically was one from the skin in which there was noted ulceration of the epiderm. In the underlying subcutis a neoplasm was noted composed of alveolar masses of polyhedral-shaped cells with pale pink cytoplasm, showing hyperchromasia of the nuclei. Areas of keratinization and definite epithelial pearls were noted. There was also a marked vascular proliferation of the small capillaries present. The deeper portions of the subcutis showed marked fibrosis and focal areas of round cell infiltration.

A letter received from the Memorial Hospital, June 5th 1941, was as follows: "Patient I. S. was first in this clinic April 6, 1940; the diagnosis was carcinoma of the cervix, primary. The patient received x-ray therapy

and was admitted May 23, 1940, for a cervix tandem, for a dosage of 3,000 mc. hrs. She was discharged May 26, 1940. She has not returned to this clinic since her discharge, but our social service department has informed us that the patient was operated upon in Mt. Sinai Hospital in March, 1941. Our pathologist reported epidermoid carcinoma, grade III, on cervical biopsy done, April 16, 1940, in this hospital."

Microscopically, the section was one of a neoplasm, which was composed of a diffuse growth of round and polygonal-shaped cells, the cells having a rather pale, granular, cytoplasm. Many mitotic figures were noted. Many of the nuclei showed marked hyperchromasia. There was no evidence of keratinization or pearl formation present. The stroma was composed of rather vascular fibroblastic tissue showing marked round cell infiltration. There was no evidence of normal cervical tissue present in the section.

A photomicrograph of a biopsy from the rectum taken at The Brooklyn Cancer Institute is shown.

Microscopic examination revealed that no normal surface lining was present. The surface was covered by a purulent and necrotic layer. The underlying tissue was composed of sheets of tumor cells arranged as multiple papillary masses. The individual cells were columnar or polyhedral in type. They had chromatic or vesicular nuclei, which varied considerably in size and shape. Regular mitotic figures were common. The stroma was infiltrated with leucocytes and plasma cells.

A follow-up of the patient, who made her last visit to the Brooklyn Cancer Institute on June 30, 1941, showed that she died at home on November 27, 1941. No autopsy was obtained.

#### SUMMARY

1. A case report is given in which a patient had four primary carcinomas: (1) A medullary carcinoma of the breast; (2) a post-radiation carcinoma in the scar of the chest wall, with recurrence; (3) a transitional cell carcinoma of the cervix, and (4) a papillary adenocarcinoma of the rectum.

2. All lesions differed histologically and no lesion was a metastasis of another.

3. It is regrettable that we were unable to show the microphotograph of the breast lesion, but we can accept the diagnosis made at so reputable an institution as the Mt. Sinai Hospital of New York.

## REFERENCES

1. ANGEVINE, D. M. Three primary malignant epithelial tumors of the anorectal region occurring in one person. *Canad. M. A. J.*, 23: 38, 1930.
2. BILLROTH, C. A. T. *Cbir. Klin.* page 258, 1869.
3. CLAYTON, E. S., JR. Multiple primary carcinomata. *Surg. Clin. North America*, 7: 93, 1927.
4. EWING, JAMES. *Neoplastic Diseases*. Philadelphia, 1928.
5. GIGLI, J. Ein fall von Zeitlich verschiedenem auftreten von carcinom. *Med. Klin.*, 23: 432, 1927.
6. GOETZE, OTTO. Bemerkungen über multiplizität tumärer carcinome in anlehnung an einen fall von dreifachen carcinom. *Ztschr. f. Krebsforsch.*, 13: 281, 1913.
7. HANLON, F. R. Multiple primary carcinomas. *Am. J. Cancer*, 15: 2001, 1930.
8. HERLEY, L. Multiple primary cancers, with report of a case. *Arch. Surg.*, 9: 204, 1924.
9. HURT, H. H. and BRODERS, A. C. Multiple primary neoplasms. *J. Lab. & Clin. Med.*, 18: 765, 1933.
10. KRETSCHMER, H. L. and HECKEL, N. J. Multiple primary malignancies. *Am. J. Surg.*, 26: 387, 1934.
11. KURTZAHN, PROF. Über multiple und wiederholte Karzinome. *Med. Klin.*, 26: 1329, 1930.
12. McNAMARA, W. L. and HECKEL, N. J. Multiple primary malignancies. *Am. J. Surg.*, 26: 387, 1934.
13. MAJOR, R. H. Multiple primary malignant tumors. *Johns Hopkins Hosp. Bull.* 29: 223, 1918.
14. ORR, J. W. Multiple malignant neoplasms. *J. Path. & Bact.*, 33: 283, 1930.
15. PORTUONDA, C. A case of three malignancies. *Am. J. Cancer*, 28: 752, 1936.
16. SCHREINER, B. F. and WEHR, W. H. Multiple primary cancer as observed at the State Institution for the study of malignant diseases. *Am. J. Cancer*, 20: 418, 1934.
17. WALTER, M. Über das multiple auftreten primärer, bösartiges neoplasmin. *Arch. f. klin. chir.*, 5: 1, 1896.
18. WARREN, S. and GATES, O. Multiple primary malignant tumors. *Am. J. Cancer*, 16: 1358, 1932.
19. WILKINS, H. and SMITH, T. H. Multiple primary malignancy. *J. Missouri M. A.*, 25: 426, 1928.
20. WOOLLEY, P. G. Notes on multiple primary tumors. *Boston M. & S. J.*, 148: 1, 1903.



# FRACTURE DISLOCATION OF THE FIFTH CERVICAL VERTEBRAE

LIEUT. LEON D. STAR

MEDICAL CORPS, UNITED STATES NAVAL RESERVE

THIS case occurred as a result of an automobile accident in the vicinity of a naval air station.

The patient, a twenty-four year old seaman, was brought to the dispensary by a private ambulance and no medical aid was given while in transit. He was seen by a medical officer about thirty minutes after the accident.

The patient stated that after the initial impact his head, acutely flexed, was thrown against the dashboard, and rotated to the right. Immediately following the injury he experienced total paralysis of the lower extremities.

Initial physical examinations revealed the following findings: Blood pressure 88/60, pulse 120. Respirations shallow and abdominal in type. The head was semi-flexed and rotated to the right side. He was unable to move the lower extremities and there was loss of cutaneous sensation up to the level of the mammary glands on both sides. The lower limbs were flaccid; no babinski sign was present. There was no ankle clonus. Chaddock's, Hoffman's and all other pyramidal tract pathological reflexes were absent. There was no knee or ankle jerk. The cremasteric and superficial reflexes were absent. The upper extremities were moved with difficulty, but the deep and superficial reflexes were normal. The cranial nerves reacted in a normal manner. Priapism was present and persisted until after pentothal anesthesia. The sensorium was not affected.

Treatment consisted of maintenance of the cervical region in traction and extreme extension; 1,300 cc. of liquid plasma was given and the patient was treated generally for shock. No morphine was used initially to avoid respiratory complications due to intracranial injury or cord involvement. A portable film of the cervical region was taken. This revealed a fracture dislocation of the fifth cervical vertebrae. The body of this vertebrae was displaced about 3 cm. dorsally obliterating the continuity of the neural canal in this area. It was assumed that the physical findings were due to compression or transection of the spinal cord

due to displacement of the fifth cervical vertebrae. Immediate reduction was decided upon. Initial therapy had improved the shock-like state. The blood pressure had risen to 110/70, the pulse was of good quality, rate 100, and it was believed that radical therapy could now more safely be instituted.

Seven cc. of 5 per cent sodium pentothal was given intravenously. Under this anesthesia traction was applied to the cervical region and the head was gently rotated to the left. An audible click was heard when the vertebrae assumed the anatomical position. There was a definite sense of crepitation experienced at the same time. Extension was maintained and the neck was then gently rotated to the right. The click and crepitation were again elicited. Upon rotation of the neck to the midline another film was taken. This revealed the vertebrae in the anatomical position. The neck was then placed in extension with a neck and semi-body cast.

Immediately after reduction there was no change in the neurological findings. The blood pressure remained sustained and in spite of the pentothal anesthesia, respirations were not embarrassed. The mobility of the upper extremities appeared somewhat improved. Priapism had disappeared and remained so after the anesthesia.

Weather conditions prohibited immediate transfer of the patient via ambulance plane to a naval hospital. However, within six hours he was placed in an ambulance plane and transported 400 miles by air. He was given oxygen en route and, in general, his condition remained unchanged.

Upon arrival at the naval hospital the patient was placed on tidal drainage and treated conservatively. Neurosurgeons reviewed the past reduction films and no further treatment was deemed necessary. The cervical cast was maintained.

On the second hospital day the patient ran a temperature of 105°F. Respirations were still of the abdominal type. An occasional dry râle was heard in both lung fields. In order to avoid

a hypostatic pneumonia he was given intravenous sodium sulfadiazine with the usual dosage. He was also placed in an oxygen tent. The lower limbs remained flaccid but a slight flexion of both great toes could be elicited upon testing for the Babinski sign. The superficial reflexes remained absent.

The patient slowly recovered from his respiratory difficulty and for the first ten hospital days there was no change in the neurological signs. About one month after the injury the patient could move his neck freely with no pain and there was almost complete return of function of the upper extremities. The lower extremities still remained flaccid, however. As the patient had been transferred to a naval hospital, complete data on neurological findings

are not available now. However, it appeared as if the patient were slowly making a recovery comparable to that of a spinal animal after complete transection of the cord.

#### SUMMARY

1. A case of complete transection of the spinal cord at the level of the fifth cervical vertebrae is presented. The writer believes that this case illustrates the necessity of immediate reduction when fracture dislocations are definitely diagnosed.
2. Five per cent pentothal sodium can safely be used as anesthesia during manipulation.



*Necrosis of bone* is due to periostitis, osteitis, osteomyelitis, irradiation or injury. *Toxic necrosis* is caused by phosphorus or mercury, often in association with bacteria. *Senile necrosis* (*quiet necrosis*) follows traumatism, probably with a mild associated infection.

From "Principles and Practice of Surgery" by W. Wayne Babcock (Lea & Febiger).

# LIVER EMBOLUS FOLLOWING HEMORRHOIDECTOMY

E. G. MARTIN, M.D.  
Proctologist, St. Mary's Hospital

AND

J. F. WENZEL, M.D.  
Junior Proctologist, St. Mary's Hospital

DETROIT, MICHIGAN

**L**IVER embolus as a complication of hemorrhoidectomy is included in the standard texts on proctology, but such a case is not revealed in a fairly extensive search of the literature.

A line of demarcation exists at the anus between the general circulation and the portal circulation through which postoperative emboli can travel to the lung, or rarely, as in this case, to the liver.

The diagnostic criteria found were: (1) Sudden upper abdominal distress gradually localizing to the right costal margin; (2) chill, followed by sharp rise in temperature and pulse; (3) nausea; (4) liver enlargement with pain on percussion or body movement, and (5) marked leucocytosis.

## CASE REPORT

On February 12, 1943, a forty-three year old, white male was admitted to the hospital for hemorrhoidectomy. During the preceding two years he had experienced occasional discomfort from prolapsing internal hemorrhoids. Periods of constipation aggravated the distress and resulted in slight bleeding. He had been treated eighteen months for *tabes dorsalis* and reported no symptoms other than numbness around the waist. His systemic history was normal. Internal hemorrhoids and a small polyp were present. The rectum and pelvic colon were normal. The Kahn reaction was four-plus, and the urinalysis and blood count were normal.

Because of the *tabes*, caudal anesthesia was substituted for the routine 50 mg. procaine spinal administration. The small anal polyp and the internal hemorrhoids were excised using the composite technic of placing a plain catgut ligature above each hemorrhoidal area followed by excision, using no sutures for approximation. One plastic isthmus was created by connecting the rectal mucosa to the skin.

The postoperative course was uneventful.

On the fourth day digital examination disclosed satisfactory progress and the patient was discharged.

During his ride home he was conscious of considerable jarring. At 9:30 P.M., three and one-half hours after dinner, he was seized with constant, severe, generalized, upper abdominal pain followed by a chill and recurrent nausea. There was no rectal pain. The next morning, on the fifth postoperative day, he returned to the hospital by ambulance.

Admission examination disclosed a temperature of 101.5°F., pulse 90, and respirations 27. The slightest body motion caused acute distress. There was point tenderness in the right upper quadrant in the nipple line 3 cm. below the costal margin. The abdomen was too tender for deep palpation. The leucocyte count was 12,250.

Twenty-four hours later, on the sixth postoperative day, the temperature rose to 103°F., with a corresponding pulse elevation but a normal respiratory rate. The liver was enlarged one-finger breadth below the costal margin and was tender to fist percussion. There were no ascites. The leucocyte count had doubled to 25,800. Blood culture taken at this time proved negative. The icteric index was normal. A few red blood cells appeared in the urine.

Medical and surgical consultation agreed on a diagnosis of "infectious hepatitis probably embolic."

Routine sulfathiazole 4 Gm. at once and 1 Gm. every four hours was started. After five days of sulfathiazole therapy the temperature, pulse rate and respirations were normal. At this time the leucocyte count was 10,650, blood sugar 105 mg., icteric index 2, direct Van den Berg negative, sulfathiazole blood level 2.3 mg. The patient was cheerful and free of distress.

Another chill occurred on the next day (eleventh postoperative), and his nose became "stopped up." On the twelfth postoperative

day the temperature rose to 102°F. The icteric index was 7 and sulfathiazole was discontinued. On the thirteenth postoperative day the temperature rose to 105.4°F., the icteric index was 3, the white count was down to 9,300, blood culture was negative. The liver enlargement had disappeared and pain was absent.

Forty-eight hours later temperature, pulse rate and respirations were again normal. The

remaining convalescence was uneventful. A glucose tolerance curve indicated liver function was normal.

The patient recovered and was discharged on the twenty-fourth postoperative day, March 10, 1943.

Previous to the advent of sulfonamide therapy, a resultant liver abscess may have had a fatal termination.



METASTASIS is both a medical and a surgical problem, yet most writers have considered it from the surgical point of view only. . . . Even when treating a simple furuncle, it is necessary to know that it can cause metastasis in the kidney and liver, or pyemia in infants, also that mumps metastasized to the testicle, pancreas, or breast in some instances.

From "Metastases Medical and Surgical" by Malford W. Thewlis (Charlotte Medical Press).



---

# Bookshelf Browsing

---

## AMERICAN SURGERY\*

### THE FIRST HUNDRED YEARS

FREDERICK A. PIZZI, M.D.

Assistant Attending Surgeon, Brooklyn Hospital

BROOKLYN, NEW YORK

OUR subject is American surgery, the first one hundred years. Space limits us to a fleeting survey, a momentary flash, an impressionistic glance at the peaks of that history. The characters in this reading were chosen as the representatives of scores of great contributors to American Surgery who are characteristic of their respective eras.

The early seventeenth century in Europe was one of great contrasts. Galileo was transforming the structure of science. Harvey, just eight years before the landing of the Pilgrims at Plymouth, announced the theory of the circulation of the blood and true medical scientists were attempting to solve the problems of diseased and normal life by new, advanced concepts. Academies of science sprang up as focal points of new knowledge. On the other hand, the Thirty Years' War had quenched nearly all intellectual life. The universities everywhere held fast to medieval forms and were incapable of perceiving the spirit of the new age. Practical medicine toddled along with the universities and was as reactionary as science was progressive. In the latter half of the century Sydenham began to bridge the yawning gap between scientific exactness and fantastic speculation and this work was not well advanced until Boerhaave's great clinical teachings began to pervade Europe in the eighteenth century. Thus it would be unjust to expect very much in medicine in the American

Colonies at a time when there was so much left to be desired in Europe.

The earliest immigrants to America encountered their first dangers on the voyage over. The small over-crowded boats were assailed by storm, shipwreck, fire and disease. Malnutrition, scurvy, influenza and small pox beckoned the hand of death and half those who with high hope and new enthusiasm set sail from Europe, died before their ships anchored in American harbors. Those who survived faced new dangers: climate, typhoid, dysentery (because of primitive water supply), yellow fever, scarlet fever, and hostile natives. No less than half those who landed with the Mayflower died within three months.

How did the colonists manage? There were practically no physicians. Most ship surgeons went back with their crews, and those few who remained were merely surgeons; men recruited from an inferior class, therapists who served an apprenticeship and who had received no academic training. We recall that many of the colonists sought refuge from religious persecution. A good number of the clergy and elders, looking to the day the churches might be closed, had trained themselves for secondary occupations, carpentry, tailoring, and some had received medical lectures. And so the colonists turned to these clergymen who functioned as minister and physician. Others of the educated

\* Read before the Brooklyn Hospital Quarterly Staff Meeting, November 9, 1942.

classes, such as governors and school masters, acted as physicians. John Winthrop, founder of Boston, sent back to England for medical books and with these and common sense, the early colonists received some primitive medicine. It must have been a peculiar mixture of religious medicine, folk medicine and some scientific principles. One invoked the Word of God, let blood or prescribed drugs to the best of one's ability.

During the eighteenth century, life in the colonies became more stabilized. New generations had been born in this land. The language and political forms of England were shared but other ties had loosened. The Atlantic crossing was tiresome and expensive. The new world was home. We had our own Cambridge with Harvard College founded in 1636. It was followed by Yale in New Haven in 1701.

Although these colleges had been founded so early there were no medical schools until half a century later. Therapy was taught by the apprentice method. As in the days of Hippocrates, a student would choose a master, go with him on his rounds, tend his horse and carriage, do chores and assist in compounding salves at home, and reading in spare moments whatever medical books were in the master's library.

A few fortunate ones, however, finished their education abroad, London and Edinburgh at that time being world centers of medical training. Laden with knowledge, the new doctors would return home and immediately would be sought after and pressed for information and instruction. Everyone wanted to learn from them and all were eager to hear what they had seen and heard.

To bring about changes, to approximate European standards, to keep step with progress abroad, this was the task of these men, these leaders who cleared the way.

Among the first was John Morgan, who lived from 1735 to 1789. He was the son of a Welsh immigrant. From earliest childhood he desired to become a physician. He followed the customary practice and

became the apprentice of Doctor John Redman, a distinguished practitioner in Philadelphia. After six years of such tutelage, coupled with academic work at the college founded by Benjamin Franklin, Morgan sailed for Europe in 1760. He studied anatomy under John Hunter and clinical medicine in Edinburgh under Cullen and Hope. After two years of this study he traveled to Geneva where he met Voltaire and then went on to Italy where he was graciously received by Morgagni who presented him with some manuscripts which are still to be seen in Philadelphia. After five years of European study and travel, Morgan returned home with an idea: "Very few of the colonists," he thought, "can afford a trip to Europe. It is high time the colonies themselves offer their sons medical education. Philadelphia has its high schools and its college. A hospital lies available" (the Philadelphia hospital had evolved from the Poor Houses in 1756 under the inspiration of Thomas Bond and Benjamin Franklin) "why not medical schools in America"?

He contacted the trustees of the college, sought and received the aid of Franklin. On May 30, 1765, at graduating exercises of the college, he made his great speech, "Discourse Upon the Institution of Medical Schools in America." He had a great deal to say and spoke for two consecutive days. Four months later the Philadelphia Medical College was opened. Four years later it possessed a faculty, the peer of any in Europe.

In 1768, ten students were for the first time in America given the degree of B. of M., the first degrees of Doctor of Medicine followed three years later.

Morgan was not a surgeon. He was, as far as I am aware, the first specialist in America. He specialized in internal medicine. He advocated the division of medical practice into specialties. We have mentioned him here because of his great contribution to American surgery through the establishment of the first medical college in America.

The century under review opened with no great lights in practical surgery. The Revolutionary War had furnished a large

head of his profession. His appointment to the Chair of Surgery in the University of Pennsylvania in 1805 greatly promoted his



FIG. 1. Philip Syng Physick, 1768-1837, The Father of American Surgery.

number of Army surgeons who rendered important services in the field and in the hospital; but there was not one at that time who was entitled to the term great in the sense employed today. Those who most nearly attained that distinction were Doctor William Shippen, the first professor at The Philadelphia College and Doctor John Warren who held a similar chair at Harvard College.

The year 1768 saw the birth in Philadelphia of Philip Syng Physick, the Father of American Surgery. When he began the practice of medicine in his native city there was no surgeon of any prominence north of New York and very few of any distinction even on this side of the line. He had returned home after an absence of four years with the prestige of foreign study, the favorite pupil of the celebrated John Hunter. Notwithstanding this prestige and training his first three years' practice netted him "hardly enough to buy the soles of my shoes." He was ready to forsake medicine for farm life. Gradually, this chilling and discouraging feeling wore off and through contacts made during his service at the Bush Hill Hospital during the fearful yellow fever epidemic of 1793, Physick began to make his mark and long before the meridian of life stood at the



FIG. 2. Valentine Mott, 1785-1865.

interests and patients were attracted to him from all parts of the country. He left no works to commemorate his fame or to record his vast experience. His contributions were more to the practice of surgery than to the science. He made valuable improvements in the treatment of leg and thigh fractures; invented ligature carriers for deep vessels, and invented a lancet concealed in a cannula for urethral strictures. He was the first to employ animal ligatures almost exclusively. He was expert at removal of cataract, devised special tonsil forceps, and was the first to lavage the stomach for poisoning. He performed lithotomy on the venerable Chief Justice Marshall from whose bladder he removed upwards of one thousand calculi. He was a master teacher. His career is epitomized by the statement "he never spilled a drop of blood uselessly or, as a teacher, ever wasted a word."

Out of the loins of this man and another, Valentine Mott of New York, have issued directly or indirectly many of the great surgical practitioners of the past.

Valentine Mott was born in Glen Cove, Long Island, in 1785. He was the son of a doctor educated at Columbia College, and then studied abroad under the celebrated Abernathy, the fascinating Charles Bell and Sir Astley Cooper. He returned to the

United States in 1809 and directly filled the Chair of Surgery in Columbia College with credit to himself and honor to his native land. He established practice at Gramercy Park and stayed in the one office until his death.

He was the originator of clinical instruction at the bedside. The list of his prodigious operations is voluminous. Sir Astley Cooper said of Mott: "he has performed more of the great operations than any man living or who has lived." He is noted for his arterial ligations. At thirty-three years he tied the brachiocephalic trunk of the innominate artery two inches from the heart for aneurysm of the right subclavian artery. A remarkable feature is that the radial pulse was not lost. However, the patient died of secondary hemorrhage. This operation was successfully performed by another surgeon forty-six years later in New Orleans. In 1828, Dr. Mott excised the right clavicle for sarcomatous enlargement. This tumor measured four inches at its base. The operation lasted four hours, was one of the greatest possible delicacy, and required an extraordinary amount of skill for its successful execution. Upwards of forty vessels were secured. The patient survived thirty years. He was the first to tie the iliac artery. He tied the common carotid arteries forty-six times for various lesions such as, aneurysm, hemorrhage, tumor, etc. He performed one thousand amputations.

In 1835, Dr. Mott visited Europe for his health, tied both carotids of a rooster in the Valley of Aesculapius and sacrificed him to the memory of the gods.

The next scene is laid on a Kentucky farm, at a place later called Motley's Glen. Thomas Crawford led the life of a hardy pioneer. His wife, Jane Todd, thought herself pregnant. She knew the symptoms for she had been delivered of five children. Her body swelled; her time grew near; but she felt no life stirring within her. Her abdomen became larger and larger and anxiety mounted. Several doctors were called in. None had any advice to give.

They suggested sending sixty miles away for Ephraim McDowell so that he might deliver her. He was known as a good surgeon. He arrived on horseback on December 13, 1809, examined the patient and found a tumor. No hospitals were to be found in that region and no professors to call on for consultation. McDowell came to the conclusion that only operation could save the patient, an unheard of risk.

No such operation had ever before been carried out. The dressing of wounds, care of broken bones, amputations, removal of stones, ruptures, tracheotomies, these were at that time the whole scope of surgery. A serious abdominal operation did not exist. The risks and experimental nature of the undertaking were explained to the patient. With true pioneer fortitude, Jane Crawford accepted the challenge. It was the middle of winter. The doctor's office and operating rooms were sixty miles away; Mrs. Crawford mounted a horse, resting the tumor on the pommel. After a necessarily slow journey of several days they arrived at Dr. McDowell's home in Danville. Then came the great moment; McDowell's nephew, a young doctor, and a young pupil assisted at the operation. The abdominal cavity was laid wide open. The patient gritted her teeth. A pedunculated cystic tumor of the ovary was found. The tube was ligated, the cyst opened, evacuated and removed. In the meantime, the patient recited psalms. The operation lasted twenty-five minutes. Visiting the patient five days later McDowell found her making her bed. She lived thirty-one years longer. Here is the story of the first ovariectomy. The pioneer spirit had won a new field for surgery.

Although a native of Virginia, McDowell earned his reputation at the town of Danville, Kentucky, where he practiced his profession from an early period of his life until the time of his death in 1830, at the age of fifty-nine years. His medical education was acquired mainly in the University of Edinburgh and in the lecture room of the celebrated John Bell of whom he was

a great admirer. In 1813, McDowell operated upon a second patient with an ovarian cyst and in 1816, upon a third patient. All were successful. He then decided to publish the story in his simple, straightforward, backwoods style. He was laughed at and ridiculed. In 1819, he brought forward two new cases. This time he was heeded. His operation became the common heritage of surgery and gynecology.

Turn now to the far off northern wilds where the waters of Lake Michigan and Lake Huron unite about the lime-cliffed island of Michilimacinac; there stands Fort Mackinac rich in the lore of Indian and voyageur and one of the four important posts on the upper lakes in the days when the Union Jack and the Tri-Color strove for the mastery of the western world. The place had become a rendezvous for Indians and fur traders. On a bright spring morning in 1822, the village presented an animated scene. The tide to the trading post was in full course and the beach was thronged with canoes and batteaux laden with pelts of the winter's hunt. Suddenly from the company store was heard the loud report of a gun and amid the confusion and excitement the rumor of an accident spread and there was a hurrying of messengers to the barracks for a doctor. In a few minutes an alert looking young man in the uniform of a United States Army Surgeon, William Beaumont, made his way to the side of the horribly mangled French Canadian, Alexis St. Martin. The chest was torn open; the left lower lung, the diaphragm and stomach were lacerated. The stomach contents spilled out mixed with blood, shreds of clothing and bone splinters. To Beaumont all seemed hopeless. Strangely enough, the man recovered. His progress was naturally slow. At first he had to be nourished artificially. Ten months later the wound was still open and a gastric fistula persisted. The man was wretched, feeble and entirely without support.

The community felt it had supported

him enough and decided to ship him back to his native Canada. Many physicians would have considered the case closed, but not so William Beaumont. He saw the journey would prove fatal and after vainly appealing to the authorities took the patient under his own roof and kept him there for two years, feeding, nursing and giving him medical care, dressing him sometimes twice a day. St. Martin gained strength and was able to walk about. The gastric fistula persisted. Beaumont decided to make use of this opportunity and began his accurate studies of gastric physiology and chemistry. With much cajoling and bribing, for St. Martin was uncooperative and indeed ungrateful, Beaumont was more or less able to keep St. Martin sufficiently long, at intervals over a period of years, to make two hundred thirty-eight experiments. The results of these were collected in a book printed in 1833 and titled "Experiments and Observations on the Gastric Juice and the Physiology of Digestion." It is a classic, simple, objective and careful. He recognized the secretions of mucus and gastric juice. He noted the antiseptic action of the latter together with its property of liquefying proteins. He also discovered it contained free acid salts. The full particulars of digestion and propulsion of individual foods as well as the effects of such stimulants as tea, coffee and alcohol on digestion were studied, and in this way he helped lay the foundation of dietetics.

Beaumont's work truly revealed the application of his ideals which he expressed thus: "Truth, like beauty is 'When unadorned adorned the most' and in prosecuting these experiments I believe I have been guided by its light."

It is questionable whether Beaumont would have become famous without Alexis St. Martin. We cannot know the answer. Chance cannot make a scientist. However, Beaumont was made of scientific stuff. A lone backwoods army surgeon ran into opportunity, recognized it and used it to

the full in spite of difficult circumstances, to give him his place among the leaders of American medicine.

The last, but in some respects the greatest, of our characters under discussion is Samuel D. Gross, known in the middle of the nineteenth century as America's Foremost Surgeon. Descended from Pennsylvania Dutch he was born on a farm near Easton, Pennsylvania, in July 1805. From earliest childhood he wanted to be a doctor. After preliminary work he matriculated at Jefferson College and was graduated from there in 1828. He was a born scientist with a special bent for anatomy and surgery. He settled in Philadelphia, which then offered the greatest opportunity to keep in touch with scientific investigations. He gradually mounted the ladder to fame becoming Professor of Surgery in Louisville, Kentucky, where he remained for sixteen years. In 1836, he was called back to Philadelphia to occupy the Chair of Surgery at Jefferson Medical College. The top rung had been reached and there he remained until his death in 1884.

In reading the life of this great doctor, one is impressed that here was a man who lacked nothing. Like Physick he was the pre-eminent surgeon of his day. Unlike Physick, he was congenial, facile in speech, and set in print the results of his vast experience and knowledge. He wrote prodigiously: monographs, pamphlets, biographies, historical treatises, translations of foreign texts, textbooks of pathology and anatomy and symptoms of surgery. Whenever his hand was not busy with the surgeon's knife, whether for operations or experiments, it would take up the author's pen. He contributed much to the knowledge of intestinal lesions; diseases, injuries and malformations of the bladder, prostate and urethra and foreign bodies in the organs of respiration. He belonged to innumerable scientific and honorary societies.

His list of accomplishments is too great to record here. The inscription to Samuel D. Gross, engraved on the urn containing

his ashes, describes the ideal American surgeon who will carry on where his fore-runners showed the way and maintains



FIG. 3. Samuel D. Gross, 1805-1884. In the middle of nineteenth century he was known as America's foremost surgeon.

America as the beacon for the highest and noblest in his art:

"Samuel D. Gross,

A Master in Surgery,

His life, which neared the extreme limits of the Psalmist, was one unbroken process of laborious years.

He filled chairs in four Medical Colleges in as many States of the Union and added lustre to them all.

He recast Surgical Science, as taught in North America, formulated anew its principles, enlarged its domain, added to its art, and imparted fresh impetus to its study.

He composed many books, and among them A System of Surgery,

Which is read in different tongues, wherever the Healing Art is practised.

With a great intellect, carefully trained and balanced, he aimed with undivided zeal at the noble and of lessening human suffering and lengthening human life, and so rose to the highest position yet attained in Science by any of his countrymen.

Resolute in truth, he had no fear; yet he was both tolerant and charitable. Living in enlightened fellowship with all laborers in the world of Science, he was greatly honored by the learned in foreign lands, and deeply loved at home."

## REFERENCES

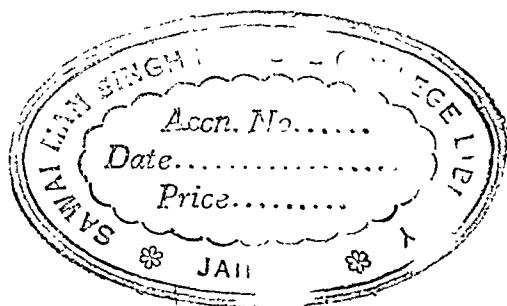
- BILLINGS, JOHN. A Century of American Medicine. 1876. H. C. Lea.  
 CASTIGLIONI, ARTURO. A History of Medicine. 1941. Alfred A. Knopf.

- GARRISON, FIELDING H. An Introduction to the History of Medicine, 4th ed. 1929. W. B. Saunders.  
 GROSS, SAMUEL D. Lives of Eminent American Physicians and Surgeons of the Nineteenth Century. 1861. Lindsay & Blakiston.  
 OSLER, WILLIAM. An Alabama Student and other Biographical Essays. Oxford, 1909. Oxford University Press.  
 PACKARD, FRANCIS R. History of Medicine in the U.S. New York, 1931. Paul B. Hoeber.  
 SIGERIST, HENRY E. American Medicine. 1941. W. W. Norton & Co.  
 THACHER, JAMES R. American Medical Biography. Boston, 1828. Richardson & Lord.  
 WALSH, JAMES J. History of Medicine in New York. 1900. National Americana Society, Inc.



IN most instances the adequate oral administration of a sulphonamide results in effective blood concentration, but undue reliance should not be placed on that happening.

From "Surgery of Modern Warfare" edited by Hamilton Bailey (The Williams and Wilkins Company).



---

---

# The American Journal of Surgery

Copyright, 1945 by The American Journal of Surgery, Inc.

A PRACTICAL JOURNAL BUILT ON MERIT

*Fifty-fourth Year of Continuous Publication*

NEW SERIES VOL. LXIX

SEPTEMBER, 1945

NUMBER THREE

---

## Editorial

### THE DIAGNOSTIC PROBLEM OF MALIGNANT BONE TUMORS

THE most valuable response of the human body to pathological conditions is that of pain. Persistent bone pain should always be given careful attention. A visit to the physician may be made because of a recent injury and may lead to the discovery of a bone tumor. A history of malaise, fever, local heat or swelling, suggestive of an infectious process, may also lead to the discovery of a bone tumor.

Patients must be constantly warned against waiting for pain to occur before consulting the physician for any suspicious lesion in the soft tissues, such as a lump in the breast. In many soft tissue malignancies, pain is not an early symptom, however.

Persistent bone ache early in the course of a bone tumor is not unusual. This is probably produced by the pressure of the growing tumor on the rigid non-expanding walls of bone. This pain may at times be described as drawing in character, or boring or rheumatic. While the pain may either develop gradually or come on suddenly or be intermittent, it is a symptom of the utmost importance and always warrants a careful search to discover the cause that produces it.

The history of the onset and course of the condition should be logically arranged and carefully evaluated. In bone tumors

the family history may be of considerable importance, for while the inheritance of tumors in man is not established, we do know that family susceptibility for malignant growths is frequently encountered. Whenever there is persistent bone pain over a few weeks, this should always be regarded as suspicious of some underlying bone disorder and studied accordingly. If we can discover the time when the region affected last felt perfectly well, we may be able to determine roughly the time of the onset of a suspected bone tumor.

In the examination the general appearance of the patient may at times be suggestive of malignancy. The age of the patient may also be of definite value in the differential diagnosis. The examination must consist of a complete general study of the patient while investigating the local area. In the case of a suspected metastatic lesion, other systems of the body may need to be studied to determine the primary lesion. The veins in the skin over the involved region may be large and prominent and the skin have a peculiar cyanotic color. Investigation of the site, size, appearance, shape and feel of the tumor mass should be made. While malignant bone tumors may occur in any part of the skeleton, there are certain sites of predilec-



tion for certain types of bone tumors as Geschickter and Copeland have so graphically pointed out in their book.

The laboratory studies should include a Wassermann or similar test, complete blood and urine examinations, and frequently blood chemistry determinations of phosphorus, calcium, phosphatase and proteins. The roentgenogram, however, is of special aid in making the diagnosis. In the past we may have leaned too heavily upon the appearance of the roentgenogram and while this valuable ally undoubtedly furnishes more data than any other one diagnostic aid, the roentgenogram must not be relied upon to the exclusion of everything else. It is unnecessary to stress the need for having as good a film as can possibly be obtained, not only of the local lesion but at times of the opposite region as well. A roentgenogram of the chest is necessary in all suspected cases of malignant bone tumors and at times a complete bone survey may be advisable. If, however, our diagnosis rests wholly on satisfactory roentgenograms, errors in diagnosis will result.

In considering the pathological report, the value and advisability of either a punch or exploratory biopsy arises. To avoid open surgery in suspected lesions, punch biopsy has been found useful, particularly in the soft tissue lesions. The method has obvious limitations in bone lesions. A negative punch biopsy is not conclusive, although a positive one may be very helpful. While the danger of a biopsy by incision and removal of sufficient tissue at times may be very real, whenever a bone lesion is surgically accessible and the diagnosis doubtful, there should be no hesitancy in recommending it. We would like to suggest in this connection that a great deal of benefit can be obtained by having the radiologist and the pathologist in the operating room when the surgeon removes tissue for diagnostic purposes. The area for microscopic section should be jointly decided

upon by these three, rather than hoping that the pathologist will intuitively section the desired area.

In tumors of the osseous system as well as malignancies in other parts of the body, early diagnosis and early treatment are always most important and, unfortunately, most difficult to obtain. In tumors of bone the old proverb, "The more certain the diagnosis, the less certain the probability of cure," is strikingly applicable.

The necessity for having a uniform classification for bone tumors is obvious, but we should like to stress the importance of using the grouping prepared by the Committee on Bone Sarcoma of the American College of Surgeons. This classification has been revised at intervals and the careful adherence to this plan has resulted in much valuable statistical information being collected.

With the array of data obtained as has been described, one might assume that a correct diagnosis can be made in all cases of suspected malignant bone tumor. Occasionally there is one other factor which enters into the picture and this is the subsequent course of the patient. Very rarely, but occasionally, even after a careful pathological report, the original diagnosis and prognosis may have to be changed as one observes the course of the patient. Therefore, the passage of time is an important factor in proving or disproving our diagnosis.

The great majority of bone tumors can be diagnosed correctly if we rigidly insist upon a careful history, a complete physical and laboratory examination, adequate x-rays, and a reliable pathological report.

In certain large medical centers, bone tumor clinics have been established and these daily illustrate the value and need of complete cooperation and coordination of all modern facilities for studying and investigating the special problem of bone tumor pathology.

PAUL C. COLONNA, M.D.

---

---

# Original Articles

---

## THE PROBLEM OF DELAYED UNION AND NON-UNION OF FRACTURES

CAPT. H. C. FETT, LT. COMDR. R. F. FOOTE AND LT. COMDR. M. A. L. STEVENS  
MEDICAL CORPS, UNITED STATES NAVAL RESERVE

AT this activity the problem of delayed and non-union is a frequent one as is evidenced by the frequent bone graft operations which appear on the operative schedule. Each week at least two bone grafts are applied for the above conditions so that over a period of a year sufficient material has accumulated to warrant the publication of the methods employed, complications and end results.

The problem of delayed union and non-union of fractures following injuries and wounds in the military service is a great one and undoubtedly stands high on the list as the cause of many sick days lost. The problem is not new and while many studies have been made in bone and joint surgery the end results of treatment in these cases often leaves much to be desired.

Fortunately most of the fractures that are seen in the military service heal without difficulty, but it is those that fail to unite which tax the ingenuity of the Naval Surgeon.

The marked comminution and compounding of bones of the extremities, with injury to blood and nerve supply and disruption of muscle pull are all factors that contribute to our problem of delayed and non-union of fractures. Infection undoubtedly contributes a major factor in the problem. Accordingly, our problem is to control and eliminate the infection, restore the bone loss, stimulate osteogenesis, correct muscle imbalance and nerve disruption, and supply rigid fixation

until such a time that satisfactory union is established.

### DELAYED UNION

Union is regarded as delayed when healing does not progress at the anticipated rate for the type and location of the fracture. As long as there is evidence either clinically or roentgenographically that the process of repair has not ceased, calcification of the fracture should be regarded as delayed.

The treatment of delayed union is largely conservative and consists principally of efficient fixation provided we can be sure that interposition of tissues between the fractured ends does not exist, and satisfactory reduction and good apposition of the fragments is present. Maintenance of muscle tone by planned exercise and physiotherapy are also useful adjuncts, as they improve the local physical tone of the tissues.

If after a reasonable period of time and observation of the above mentioned facts we find that little evidence of callus formation and union is present, we are then justified in undertaking more extensive and radical procedures rather than risk further delay in convalescence. Under these circumstances we have resorted to the operation of drilling of the fragments about the site of the fracture.

Drilling is not a new procedure but was first described in detail by Daniel Brainard in 1854.<sup>1</sup> The procedure is not difficult and consists principally of drilling

six to twenty holes obliquely across and through the fracture site. By this means, osteogenesis may be stimulated through



FIG. 1. X-ray evidence of non-union. Cupping, thin cortex, widened medullary cavity; bone atrophy; bone sclerosis.

increased circulation to the fractured surfaces from the periphery of the bone. Following this procedure, the extremity is immobilized in plaster for a period of six weeks or as long as is necessary to secure union after which further treatment is carried out as planned for a fracture in which union is not delayed. Our results with this method have been most successful when used for fractures of the tibia, but the procedure may be used with success in treatment of delayed union of any of the other long bones.

#### NON-UNION

When a fracture in a bone fails to unite, non-union is said to exist. For years, six months has been accepted as a sufficiently long period to wait for union to occur.<sup>2</sup> However, it is often possible to determine by x-rays, long before this time, whether or not union will take place. This interval varies, as union has often occurred after a longer period, especially following some complication such as infection.

The end result of non-union may be one

of three types:<sup>3</sup> (1) Pseudoarthrosis, (2) fibrous union with osteoporosis of the fragments, and (3) fibrous union with atrophy of tissue.

1. *Pseudoarthrosis* is characterized by the formation of a shallow cup usually on the proximal fragment which apparently is the result of greater functional stimulation of this fragment. Callus forms on each fragment rather than across the fracture line and obliterates the medullary canal. The bone appears sclerosed and is of inferior quality closely resembling scar tissue.

2. *Fibrous union* with osteoporosis is characterized by rapid, irregular absorption of lime salts as is evidenced by mottling of the fragments. The process extends for a considerable distance to each side of the fracture line and while the cause of this phenomenon is not definitely known it has been suggested that the vasomotor and sympathetic nervous systems may play a part in its development.

3. *Bone atrophy* of disuse is usually always present and progresses with the passage of time. It is related to the loss of functional stimulation of cellular activity by disuse. The bone appears pale and its transverse diameter appears to be decreased. At operation it is not unusual to find that the bone cortex is thinner while its marrow appears to be enlarged and is filled by an increased amount of fat. Decreased vascularity is also a common finding.

Having considered the types of non-union as revealed by x-ray (Fig. 1), it might be well to consider the other factors that may play a part in the development of our problem.

1. *Constitutional Factors.* Undoubtedly systemic disease may play a large part in the development of this problem. However, the serviceman is usually in the best of health prior to injury, as he is young and well nourished. Although his injury is severe "he still has enough fight left in him to bounce back." If another disease is present, we treat it but we do not believe

this factor is prominent in our young serviceman.

Vitamins, calcium and phosphorous studies, blood proteins and endocrine factors must all be considered but we have not been able to demonstrate by available laboratory studies that these factors play an important rôle in our problem. In fact it has been most unusual for us to demonstrate any disturbance in the body chemistry.

2. *Inadequate nutrition* of the bone due to site of fracture and injury to the nutrient arterial system probably plays a large part in the development of the problem of non-union. Injury to the periosteum with its concurrent impairment of circulation to the part also adds to the problem. With loss of circulation or diminution thereof we may expect the process of healing to be retarded. This is well brought out in fractures through the neck of the femur. This contributes to the delay and non-union of fractures through this site.

3. *Nerve influence* on the site of fracture still is not clear. Muscatello and Damaschelli<sup>5</sup> found that after section of the peripheral nerves there was no disturbance in the formation of callus and consolidation and union occurred without delay.

The rôle of the sympathetic nervous system in non-union is likewise not clear. Felix<sup>6</sup> in his experiments on dogs, resected the ganglion, and after section of the shafts of the tibia and ulna, more than half of the cases showed acceleration of union on the sympathectomized side, due to resulting hyperemia. Defect pseudoarthrosis developed only when the periosteum was removed.

While much work is yet to be done before the exact rôle of nerve influence can be definitely worked out, we believe that additional nerve injury in fractures contributes to our problem as it delays the return of function to the affected part and contributes to muscle imbalance.

4. *Infection* continues to be a "bugaboo" to the surgeon. Until it can be controlled and eradicated our final treatment of

fractures is often delayed. Its concomitant destruction of bone and resulting bone sclerosis is deleterious as far as bone repair is concerned, and often the bone at the fracture site after infection is found to be hard, dense, and deficient in circulation and osteogenetic powers.

5. *Interposition of tissues* continues to remain high on the list of causes of non-union.<sup>7</sup> While some fractures may go on to complete union despite the interposition of soft tissue, one cannot help but notice at operation how often muscle and periosteum is found interposed between the fractured ends. Undoubtedly this tissue contributes to delayed union and non-union, and upon removal and freshening of the ends of the fractured fragments, union may occur.

6. *Insufficient immobilization* practiced by the impatient surgeon is a frequent cause of delayed union and non-union. As soon as a fracture is reduced and the bone ends are placed in apposition, rigid fixation and immobilization must be maintained if healing of the fracture is to progress satisfactorily.<sup>8</sup>

While plaster remains the best method of immobilization in general use, we must not forget that a cast that appears snug and comfortable after application may become loose after swelling has subsided and muscle atrophy of disuse has developed. When this occurs, a new cast must be applied if adequate immobilization is to be continued. A loose cast with motion at the fracture site in early fractures will contribute toward disruption of the process of repair. The young capillaries are ruptured and the cellular arrangement of new callus is disturbed. The forces that produce pseudoarthrosis are shear, and friction, and if this is to be avoided strictest immobilization must be maintained. The joints above and below the fracture site must be immobilized. Once healthy and well nourished callus is formed, motion is stimulating.<sup>9</sup> Motion earlier than this will delay the process of healing and disturb the bony contact at the fracture site, all

of which tends to prolong the process of healing.

The fracture must be reduced early and immobilization must be satisfactory and prolonged until such a time that x-rays reveal sufficient callus.

While the causes of non-union may be many, the vast majority are due to imperfect anatomical reduction and to lack of adequate immobilization.<sup>9</sup>

#### OPERATIVE TREATMENT OF UNUNITED FRACTURES

Having considered the many factors that may contribute to the development of non-union we now turn to the various operative procedures at our disposal.

When a fracture fails to unite after a sufficient interval of time, operative interference is usually indicated.<sup>10</sup> The object is to provide extra bone for the bridging of gaps, filling of defects, and stimulation of osteogenesis, after which immobilization in satisfactory position is to be continued until union occurs. The sooner the condition is recognized and treated the better the chance of success and the shorter will be the patient's convalescence. Having obtained clinical and x-ray evidence of non-union, the case must be evaluated and the predisposing causes if known eliminated. All medical and surgical aides at our disposal must be brought into play as the patient must be in the best physical condition possible prior to operation. Blood, iron and vitamins are used freely and all contributing factors to non-union are eliminated as far as possible.

The accepted treatment of non-union is the transplantation of an autogeneous bone graft, and in the treatment of our patients with non-union we have used autogeneous bone grafts whenever possible.

The use of bone grafts is not new. Jentzer<sup>11</sup> mentions the use of bone grafts in India as early as 500 B.C.; however, it was not until the latter part of the last century that the use of bone grafts came into its own. The work of Albee<sup>12,13,14</sup> during the past thirty-five years has done

much to stimulate interest in bone grafts and standardize their use in this country.

Experience has clearly demonstrated the inefficacy of certain types of grafts and the value and indications of others. Bone grafts are used in ununited fractures chiefly to fill defects, aid in fixation, aid in re-establishing circulation and to promote osteogenesis. Of the many and varied types of grafts considered in the literature we have limited our use to one or more of the following grafts. (1) Inlay graft, (2) onlay graft, (3) osteoperiosteal grafts (wafer), (4) intramedullary grafts, and (5) primary bone grafts.

In obtaining our autogeneous bone grafts we have usually selected the medial aspect of the tibia for the donor site. The graft is cut with a bone saw and is  $\frac{1}{2}$  to  $\frac{3}{4}$  inch across and is six to eight inches long or as long as is required and includes all three types of bone, namely, periosteum, cortex and endosteum. Prior to cutting our graft the fracture site is exposed and freshened by means of a motor-driven saw. The marrow cavity at the fracture site is usually found to be closed off by avascular sclerotic bone, and by curettage or drilling the marrow cavity can be opened to allow better vascularization which will enhance the process of union. Having completed the freshening of our fracture site we now obtain satisfactory alignment and apposition under direct vision. Satisfactory reduction is maintained by bone clamps and the desired type of graft is cut and placed over the fracture site. Two or more drill holes are placed through each end of the graft and fractured segments and then fixed by vitallium screws. The wound is closed in an accepted manner and plaster immobilization is applied and maintained until clinical and x-ray evidence of union has occurred.

The *inlay bone graft* was first used by Albee. The inlay and sliding inlay bone graft has been found in our experience to be more adaptable to use in fractures of the tibia. Having refreshed the fracture site and obtained satisfactory reduction

FIG. 2.

FIG. 3.

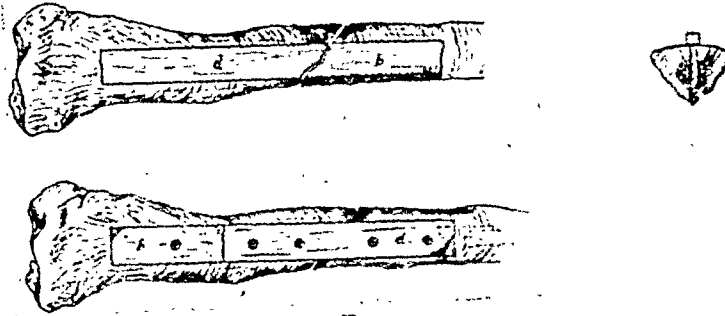
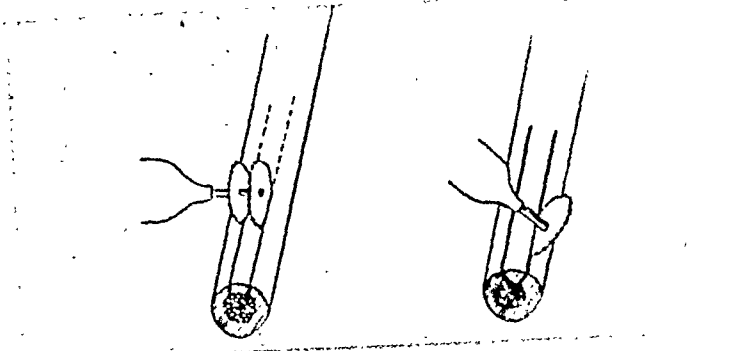


FIG. 4.

FIG. 2. Double blade saw.

FIG. 3. Single blade saw.

FIG. 4. Sliding bone graft.



FIG. 5.



FIG. 6.



FIG. 7.

FIG. 5. Case 1. Post-reduction plate.

FIG. 6. Case 1. Four months after plating. Clinically non-union; pain and motion at fracture site; patient has fractured five out of seven screws.

FIG. 7. Case 1. Eight weeks after bone graft; union by x-ray and clinically.

we cut a graft that is usually six inches long and one-half inch wide and extends from healthy bone down to and across the

is held snugly by at least two vitallium Phillips head screws to each fracture fragment. The periosteum is closed as are

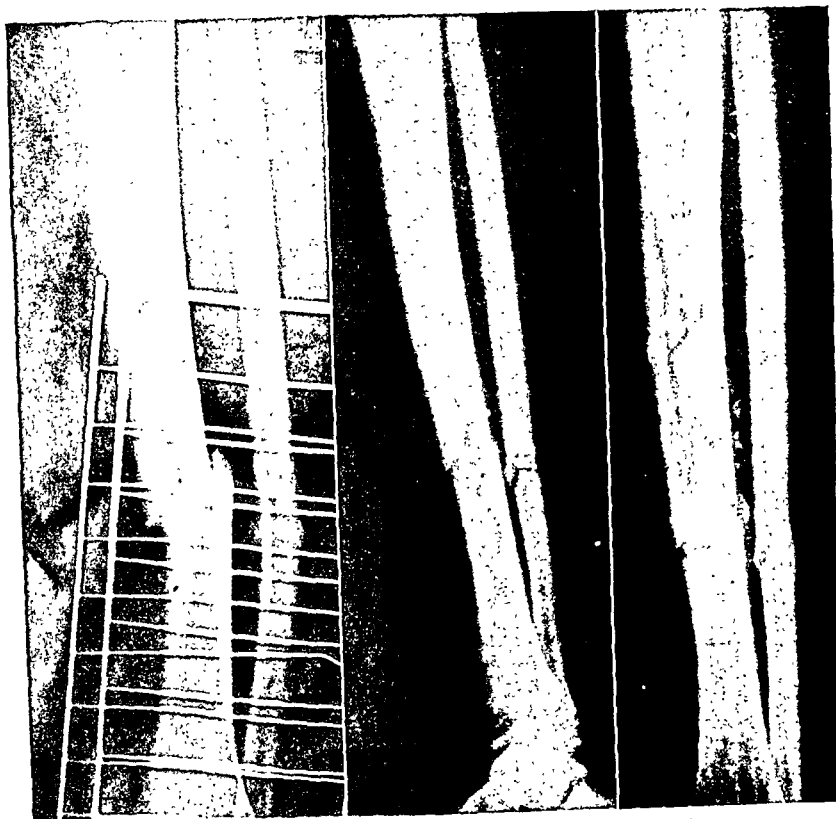


FIG. 8.

FIG. 8. Case 11. Oblique fracture of right tibia and fibula August 1, 1944, in war zone.

FIG. 9.

FIG. 9. Case 11. Open reduction; four-hole plate inserted five weeks after plating overseas.

FIG. 10.

FIG. 10. Case 11. Seven weeks after tibial sliding graft; six months after original fracture. Early evidence of union of graft; callus across fracture site.

line of fracture. The graft may be cut with a parallel blade saw or with a single blade saw. If the double blade saw is used (Fig. 2), the graft may often be smaller than the space from which it was cut and as a result it may sink into the medullary cavity. If the graft is cut with a single blade saw (Fig. 3) and the saw is directed in an oblique direction toward the medullary cavity, the sliding graft will fit more snugly in its new position and give a certain amount of fixation. Having cut the graft it is now reversed and set in its trough. The longer portion bridges the fracture site. (Fig. 4.) The shorter fragment is fitted into the remaining space. The graft

the overlying tissues and the limb is immobilized by the application of a high thigh plaster case. Three cases are presented to illustrate this type of bone graft.

#### CASE REPORTS

CASE 1. The patient, age eighteen, while playing baseball, was knocked down by another player. As a result, he sustained a simple comminuted fracture of the left tibia and fibula through the middle third. On August 18, 1944, an open reduction was done and a six-hole vitallium plate was applied. One additional transfixation screw was used to hold the largest comminuted fragment in place. (Fig. 5.) A high thigh plaster cast was applied. Six weeks later considerable callus formation was present

and limited weight bearing was started. Four months after fracture (Fig. 6), the patient had marked callus formation. Five out of seven screws were broken and there was marked anterior bulging of callus. Pain and motion at the fracture site were present. Open operation revealed fibrous union and the excess callus was removed, bone ends freshened and a sliding bone graft inserted. A high thigh plaster cast was applied. Eight weeks after the bone graft was inserted (Fig. 7) union was present clinically and by x-ray.

**CASE II.** This patient, age twenty, was knocked down and trampled during an air raid and sustained a simple spiral type fracture at the junction of the middle and lower thirds of the right tibia and fibula. (Fig. 8.) Because of angulation, poor apposition and shortening, an open reduction was done and a four-hole vitallium plate was used to maintain reduction. (Fig. 9.) High thigh plaster was applied and the patient was evacuated to the mainland. Three months later the plaster cast was removed. Union appeared to be present clinically and the patient was started on physiotherapy and weight bearing. Six weeks after removal of the cast the patient complained of pain and motion at the fracture site. X-rays revealed evidence of non-union. Clinically non-union was present. Open operation revealed fibrous union. The fracture site was freshened and a sliding tibial bone graft was inserted after which a high thigh plaster cast was applied. Seven weeks later the cast was removed. The wound was well healed and clean. X-ray evidence of early union of bone graft and moderate callus production across fracture site was present. (Fig. 10.) A high thigh plaster cast was reapplied and will be maintained until there is x-ray and clinical evidence of solid union.

**CASE III.** This patient, age twenty-six, sustained a compound transverse fracture of the right tibia at the junction of the lower and middle thirds on September 25, 1944, when struck by a falling steel plate. The wound was debrided, the fracture reduced and the leg incorporated in a high thigh plaster cast after which he was evacuated through various hospitals overseas and arrived on the mainland ten weeks later. X-rays revealed considerable angulation and little evidence of union. Clinically non-union was present fourteen weeks after injury. (Fig. 11.) The deformity was cor-

rected and a sliding tibial bone graft was inserted. X-rays were taken four weeks after the sliding tibial bone graft was applied.

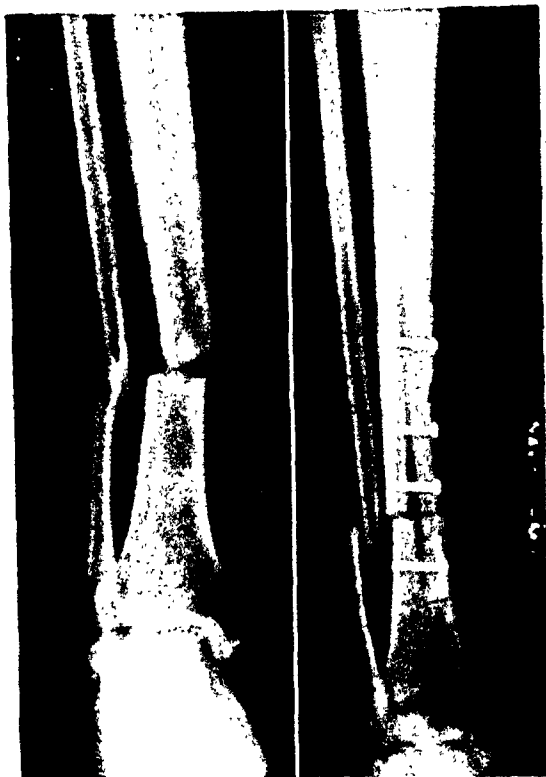


FIG. 11.

FIG. 11. Case III. Fractured tibia and fibula fourteen weeks after injury; angulation, deformity and no evidence of union.

FIG. 12.

FIG. 12. Case III. Six weeks after sliding tibial bone graft. Position satisfactory; no evidence of union. Graft appears to be broken; x-ray film<sup>1</sup> proves this to be untrue as trabeculae are visible across the apparent fracture of the graft.

The deformity was corrected six weeks after bone graft. (Fig. 12.) The position remains satisfactory but there is no evidence of union as yet.

The *onlay bone graft* was popularized by Campbell and Henderson. This type of graft has found its best use in treatment of fractures of the humerus, bones of the forearm and femur. It has the advantage in that a massive graft can be applied and the size is not limited by the size of the trough; in fact, a double onlay graft may be used when indicated.

Here again the fracture site is freshened as is the recipient site for the graft and in the meanwhile a second team cuts a



tibial bone graft of desired length and width. The spongiosa is paired down with the bone saw so that the graft presents a

fracture line. Vitallium Phillips head screws are inserted and reduction is maintained by a snug fitting onlay graft. The spongiosa

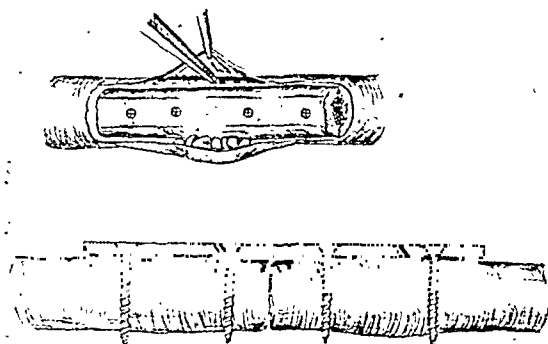


FIG. 13. Onlay bone graft.

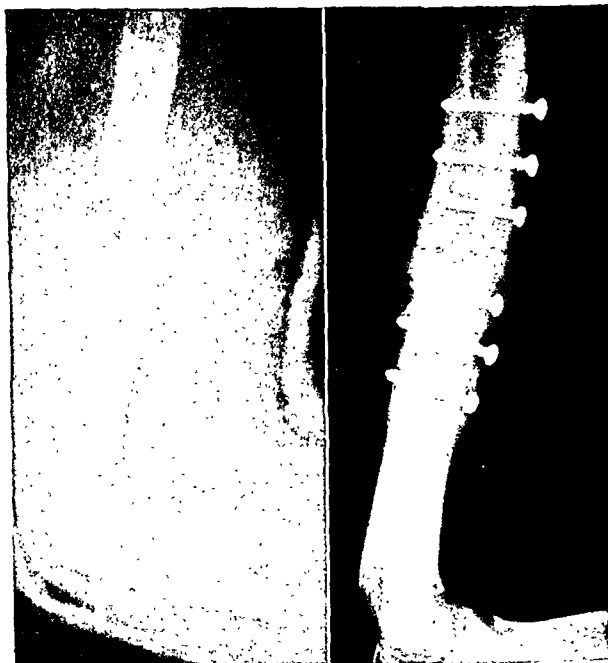


FIG. 14.

FIG. 15.

FIG. 14. Case IV. Fracture of humerus, August 7, 1944. Treated by hanging plaster method for three months.

FIG. 15. Case IV. Eleven weeks after onlay bone graft; union clinically and by x-ray.

flat surface on its medullary side. The bone graft is then laid across the freshened fracture site which has been reduced and held in firm apposition under direct vision by means of bone clamps. Two or more drill holes are made in the graft and recipient site to each side of the

chips are then laid about the fracture line to fill in any defect that may exist. (Fig. 13.)

We have used massive onlay tibial grafts on some of our patients with non-union of fractures of the femur. However, unless satisfactory immobilization is maintained over a prolonged period, the risk of

fracturing the graft is great. To help overcome this possibility we have often used a vitallium plate in conjunction with the bone graft.

**CASE IV.** On Aug. 7, 1944, while operating a boat hoist, the patient, aged twenty-two, slipped and fell against the bulkhead and sustained a simple transverse fracture of the right humerus at the junction of the lower and middle thirds. (Fig. 14.) He was treated by the hanging plaster cast method for three months. Because of lack of evidence of union, poor apposition of fragments and angulation, an onlay tibial bone graft operation was performed on October 16, 1944, and a plaster body cast with arm spica at 45 degrees was applied. Union was present clinically and by x-ray eleven weeks later. (Fig. 15.)

**CASE V.** On October 7, 1943, this patient, age twenty-three, fell from a truck and sustained a simple transverse fracture of the left humerus. He was treated successfully by the hanging plaster cast method. On January 25, 1944, he slipped and fell and refractured his left humerus through the old fracture site. (Fig. 16.) On February 5, 1944, an onlay tibial bone graft operation was performed. Union progressed satisfactorily thereafter and on September 11, 1944, union was firmly established clinically and by x-ray. Muscle rehabilitation had almost completely restored function. (Fig. 17.)

**CASE VI.** This patient, age twenty-three, sustained a simple, comminuted, transverse fracture of the upper one-third of the right femur, when his ship struck a mine off the coast of Normandy. He was thrown into the air and then fell through a hatch and landed two decks below. He was treated by skeletal traction and then incorporated in a plaster spica and evacuated to the mainland. Three and one-half months after injury, marked medial angulation and considerable callus formation was present. (Fig. 18.) Sixteen weeks after injury an open operation was performed, angulation corrected and a large tibial onlay graft applied and held in place by seven screws. A body cast with a right leg spica was applied. Sixteen weeks after the bone graft operation, union was present clinically and by x-ray. (Fig. 19.)

**CASE VII.** This patient, age twenty-one, sustained a compound, comminuted subtro-

chanteric fracture of his right femur when his ship was torpedoed on August 5, 1944. He was treated by skeletal traction and then placed in



FIG. 16.

FIG. 17.

FIG. 16. Case v. Treated successfully by hanging plaster method; three and one-half months later; refracture through fracture site.

FIG. 17. Case v. Seven months after onlay tibial bone graft; union clinically; x-ray film demonstrates considerably more repair than is apparent in this photograph.

a double hip spica and evacuated to the mainland. Examination seven weeks after injury revealed angulation, poor apposition and minimal callus. (Fig. 20.) Eleven weeks after injury, open reduction with application of tibial onlay graft and a four-hole vitallium plate and screws was performed after which a body cast with a right leg spica was applied. Sixteen weeks after the bone graft operation, union appeared to be present clinically and was substantiated by x-ray. (Fig. 21.)

*Osteoperiosteal Bone Grafts (Wafer Graft).* This resembles the onlay graft but is considerably thinner. We have referred to them as "wafer grafts" and have used them successfully in cases of non-union of fractures of bones of the forearm. They contain periosteum, cambium layer and some cortical substance and are prepared in the same way that the onlay graft is except that spongiosa as well as part of the

cortex is removed and as a result we have thin cortical graft which is applied across the previously prepared fracture site and

Angulation and non-union developed and on June 14, 1944, two "wafer grafts" were applied across each fracture site and were



FIG. 18.

FIG. 18. Case vi. Fourteen weeks after injury; angulation, poor apposition and minimal callus.



F.G. 19.

FIG. 19. Case vi. Sixteen weeks after bone graft operation; union clinically and by x-ray.

held in place by four screws or wires. Our osteoperiosteal or "wafer" grafts are a little thicker than those described by Delangeniére.<sup>15</sup> We cut our graft in the same way that we cut an inlay graft after which we pare the graft down with the bone saw. The resulting graft is about one-half the thickness of the cortex of the tibia. A certain amount of care must be used in applying the graft and drilling the holes in order that the graft is not fractured.

**CASE VIII.** On January 10, 1944, this patient, age twenty-eight, sustained a simple transverse fracture through the middle third of the right radius and ulna (Fig. 22) when he bailed out of his plane and was struck by the tail fin. The fractures were reduced and the forearm and arm were immobilized in plaster.

held in place by wires at each end of each graft. A plaster cast was applied from axilla to metacarpal heads with the forearm in midposition between pronation and supination and the elbow at a right angle. (Fig. 23.) Union was firm fourteen weeks later. Follow-up six months after the bone graft operation revealed full return of function. (Fig. 24.)

**CASE IX.** This patient, age twenty-seven, slipped and fell thirty feet and landed on his left forearm and sustained simple fractures of ulna and radius at the junction of the upper and middle third. (Fig. 25.) An intramedullary Kirschner wire was inserted in the ulna and the malposition was corrected. (Fig. 26.) A plaster cast was applied from axilla to metacarpal necks with the hand supinated. The position of the radius was satisfactory. Five months later the radius was united but the ulna showed

no evidence of union. An open operation was performed and an onlay tibial (wafer graft) was applied and secured with four vitallium screws after which the extremity was immobilized in plaster. Ten weeks later (Fig. 27) union was present clinically and by x-ray and the patient was started on muscle rehabilitation.

#### INTRAMEDULLARY BONE GRAFTS

Intramedullary bone grafts have been used with variable results. Most authorities agree that the graft has little to offer for when the bone peg is cut and inserted into the medullary canal and across the fracture site, it embarrasses further an already depleted circulation to the bone fragments. While we do not advocate the general use of this graft when more reliable procedures are available, we do think that there are a few instances when the graft may be used to fill defects and realign separated fragments in the small bones such as the metacarpals and metatarsals. The use of a larger graft presents difficulties in these areas due to irregular and painful protrusions particularly when used close to a weight bearing surface.

**CASE X.** This patient, age forty-two, sustained multiple severe injuries and a compound fracture of the first left metatarsal when his ship was torpedoed on September 11, 1943. He was treated by plaster immobilization and non-union developed. (Fig. 28.) On April 5, 1944, the fracture site was prepared and an intramedullary tibial bone peg was inserted. Position was satisfactory thereafter and union occurred four and one-half months later. (Fig. 29.)

**CASE XI.** This patient, age twenty-two, received a gunshot wound of the right foot during the invasion of Saipan. A compound comminuted fracture through the shaft of the third right metatarsal was sustained. Débridement and plaster immobilization led to healing of the wound. Sixteen weeks later (Fig. 30) considerable comminution and non-union were present and an intramedullary tibial bone peg was inserted to fill the metatarsal defect and to aid in fixation after which a plaster boot was applied for immobilization. Twelve weeks later

adequate fixation persisted and the defect had been filled. There was little evidence of union. Sixteen weeks later, minimal callus



FIG. 20.

FIG. 21.

FIG. 20. Case VII. Compound subtrochanteric fracture of femur; seven weeks after injury; angulation; poor apposition; minimal callus.

FIG. 21. Case VII. Sixteen weeks after onlay tibial bone graft; union clinically and by x-ray.

formation was present and there is early evidence of union. (Fig. 31.)

#### PRIMARY BONE GRAFTS

A primary bone graft is one that is used shortly after an injury is sustained. It has all the advantages of the other bone grafts plus the added factor that it is used early and long before non-union has occurred and therefore theoretically should be an added and early stimulus to union. Perhaps its greatest use will be in the early treatment of fractures by open reduction and fixation at the sites that are notorious for non-union. We have used a primary sliding inlay graft in one case of spiral oblique fracture of the tibia at the junction of the lower and middle thirds. Progress has been satisfactory thus far or six weeks after the operation was performed. Further

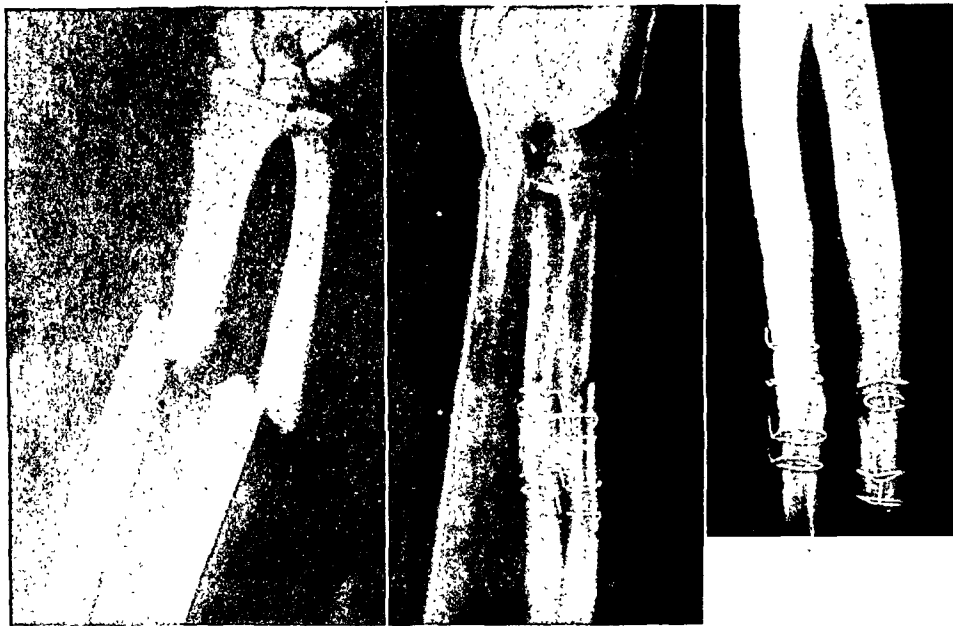


FIG. 22.

FIG. 23.

FIG. 24.

FIG. 22. Case VIII. Fracture of right radius and ulna January 10, 1944.  
FIG. 23. Case VIII. Wafer grafts in place; angulation corrected.  
FIG. 24. Case VIII. Six months after application of "wafer grafts"; union solid clinically and by x-ray; full return of function.



FIG. 25.

FIG. 26.

FIG. 27.

FIG. 25. Case IX. Fracture, simple, of left radius and ulna.  
FIG. 26. Case IX. Fracture of left radius and ulna one month later; intramedullary wire to secure alignment of ulna.  
FIG. 27. Case IX. Ten weeks after "wafer graft" to ulna; union clinically and by x-ray.



FIG. 28.

FIG. 28. Case x. Non-union of first left metatarsal, seven months after injury.



FIG. 29.

FIG. 29. Case x. Union of fracture of first left metatarsal, eleven months after injury and four and one-half months after intramedullary bone graft.



FIG. 30.

FIG. 30. Case xi. Sixteen weeks after gunshot wound of right foot; non-union, bone defect of third right metacarpal.



FIG. 31.

FIG. 31. Case xi. Sixteen weeks after bone graft operation; early evidence of union.

studies undoubtedly will have to be made before definite conclusions can be drawn.

CASE XII. This patient, age thirty-four, slipped and fell on the icy ground and sustained



FIG. 32.

FIG. 33.

FIG. 32. Case XII. Fracture, simple, at junction of lower and middle thirds of tibia.

FIG. 33. Case XII. Primary bone graft of tibia six weeks postoperatively; minimal callus formation; beginning evidence of union.

a spiral type fracture of the right tibia, 6 inches above the ankle joint, and a comminuted fracture of the fibula in its upper third, on December 22, 1944. (Fig. 32.) On December 27, 1944, a sliding tibial bone graft operation was performed after satisfactory reduction was obtained. A high thigh plaster cast was applied. Six weeks later position remains satisfactory. Callus formation and beginning evidence of union of bone graft is present. (Fig. 33.)

#### CHEMOTHERAPY AND BONE GRAFT SURGERY

Having had an opportunity to see innumerable casualties in the war zone and on the home front, we believe quite definitely that the use of penicillin and sulfonamide drugs have contributed much to the lowered incidence of wound infection. While we do not believe the use of these drugs will cover errors in surgical technic, we do believe that their use has

done much to reduce the incidence of infection after well controlled and well performed surgery.

In our patients with clean wounds that have never been infected, we routinely sprinkle the donor site and grafted areas with a light frosting of microcrystalline sulfathiazole. Postoperatively, the patient is placed on penicillin and given 20,000 units every four hours for five to seven days. Our incidence of infection has been remarkably low.

In our fractures that have previously been compound and infected, we here again use sulfathiazole as above. Penicillin is given in the above dosage for seven days preoperatively and for ten days postoperatively. Our incidence of infection has been very low. In the past, patients who have been infected and needed further reconstructive surgery were often not brought to final surgery until six months to one year after the infection had subsided. We have operated upon many of these patients three months after the infection and drainage had subsided and here again our incidence of infection has been remarkably low.

We believe that the use of chemotherapy has a definite rôle in reconstructive bone surgery in the prevention of operative and postoperative infection. We strongly recommend the pre- and postoperative use of penicillin and the use of sulfathiazole powder at operation in the operative wound.

#### POSTOPERATIVE COMPLICATIONS

1. Infection in the past has been the greatest source of failure in bone graft surgery.<sup>16</sup> If the infection is severe and extensive, it is not unusual for the graft to be lost. However, if the infection is well localized, free institution of adequate drainage may often lead to control of infection and saving of the graft which often then goes on to satisfactory union. Chemotherapy has done much to prevent this complication. It has not been our greatest source of failure.

2. *Fractures of the graft* may occur and under some circumstances such a complication may prove serious. Whenever immobilization is not satisfactory, fracture of the graft may be anticipated. The graft probably has its greatest strength immediately after operation. Following operation there is a period of transformation in which the graft becomes more fragile as union progresses. This is followed by a long period in which the graft becomes progressively stronger, thicker and heavier (in accordance with Wolff's Law). In any event the graft becomes much weaker before it gets stronger and if immobilization is not adequate before union occurs the graft may be fractured. This complication has occurred in a few of our patients in whom we placed an onlay graft on the femur. In each instance it was due to inadequate immobilization. One of our patients was a youthful athlete who tried to chin himself on the fracture bed bars despite the fact that he was immobilized in a body cast with a leg spica. Undoubtedly this unusual exercise contributed to his complication. Each patient requires careful watching preferably by the operator.

3. *Fracture of the Donor Site.* Having removed a bone graft from the donor site (tibia), the extremity should be protected from unusual stress or strain for the next few months until sufficient new bone is formed to strengthen the defect. Several of our patients have fractured the donor site when they indulged in unusual and strenuous exercise while on liberty. One patient (Figs. 34 and 35) slipped on the ice and fractured not only the donor site but both "wafer grafts" in his forearm. This complication is most unfortunate for obvious reasons. Here again careful supervision of the patient's activities must be followed if a prolonged convalescence is to be avoided.

#### SUMMARY

An unusual number of rehabilitative problems have been encountered at the

U. S. Naval Hospital, St. Albans, requiring bone grafts. No attempt has been made to present unusual results or procedures.



FIG. 34.

FIG. 34. Case XIII. Complication—fracture of tibial donor site. Patient slipped and fell and fractured the tibial donor site as well as the onlay wafer grafts.

FIG. 35.

FIG. 35. Case XIII. Complication—fracture of bone grafts.

Typical cases requiring surgery and an operative corrective method have been presented. Despite lack of prolonged follow-up of many cases, it is believed that the results are uniformly good and justify the operative procedure. Pre- and post-operative use of penicillin is advocated. The use of sulfathiazole powder in the operative site is recommended. Adequate and prolonged immobilization is imperative. Complications were discussed and means of obviating them presented. Bone grafting in many war casualties offers the only possible hope for re-establishment of alignment and function.

#### REFERENCES

1. BRAINARD, DANIEL. New Method of Treating Ununited Fractures and Certain Deformities of



- the Osseous System. New York, 1854. Baker, Goodwin & Co.
2. KIRK, NORMAN T. Basic principles of bone transplantation. *Bull. U.S. Army Med. Dept.*, 39: 75, 1944.
  3. CAMPBELL, WILLIS C. Operative Orthopedics. St. Louis, 1939. C. V. Mosby Co.
  4. LEXER, E. Ueber die Entstehung Von Pseudoarthrosen und Franksturen. *Arch. f. klin. Chir.*, 119: 520, 1922.
  5. MUSCATELLO, G. and DAMASCHELLI, D. Einfluss der Nervendurchschneidung auf Heilung von Knochenbruechen. *Arch. f. klin. Chir.*, 58: 937, 1899.
  6. FELIX, W. Beziehung des Nervensystems zur Entwicklung und Knochenregeneration. *Deutsche Ztschr. f. Chir.*, 193: 196, 1925.
  7. STEINDLER, A. Orthopedic Operations. Springfield, 1943. Chas. C. Thomas.
  8. POMMER, G. Zur Kenntniss der Mikroskopischen Befunde bei Pseudarthrose. *Wien. klin. Wchn-schr.*, 11: 328, 1917.
  9. STIRLING, ROBERT I. The causation of delayed union and non-union of fractures. *Brit. M. J.*, 219: 2, 1939.
  10. KEY, ALBERT J. The choice of operation for delayed and non-union of long bones. *Ann. Surg.*, 118: 665, 1943.
  11. JENTZER, A. Functional restoration by means of autoplasmic bone grafts. *Schweizer. med. Wchn-schr.*, 73: 1023, 1943.
  12. ALBEE, FRED H. Bone Graft Surgery, 1915.
  13. ALBEE, FRED H. Bone Graft Surgery in Disease, Injury and Deformity, 1940.
  14. ALBEE, FRED H. Evolution of bone graft surgery. *Am. J. Surg.*, 63: 421, 1944.
  15. DELAGENIERE, H. and LEWIN, PHILIP. A general method of repairing loss of bony substance and reconstructing bones by osteoperiosteal grafts taken from the tibia. *Surg., Gynec. & Obst.*, 30: 440, 1920.
  16. GHORMLEY, RALPH K. Choice of bone graft methods in bone and joint surgery. *Ann. Surg.*, 115: 427, 1942.



SOUND bony union of the scapulo-humeral articulation in the optimum position of abduction in front of the coronal plane ensures a most useful limb which provides power and stability, although its excursions are limited.

From "Surgery of Modern Warfare" edited by Hamilton Bailey (The Williams and Wilkins Company).

# GLASS PLASTIC CAST

ROGER ANDERSON, M.D. AND HERBERT R. ERICKSON, M.S.  
SEATTLE, WASHINGTON

IN a recent article,<sup>1</sup> one of the authors discussed the attributes of an ideal cast, and described a new, open-mesh, as resistance to water, lightness of weight, porosity, transparency to x-ray, and cleanliness in application. (Figs. 1, 2, and 3.)

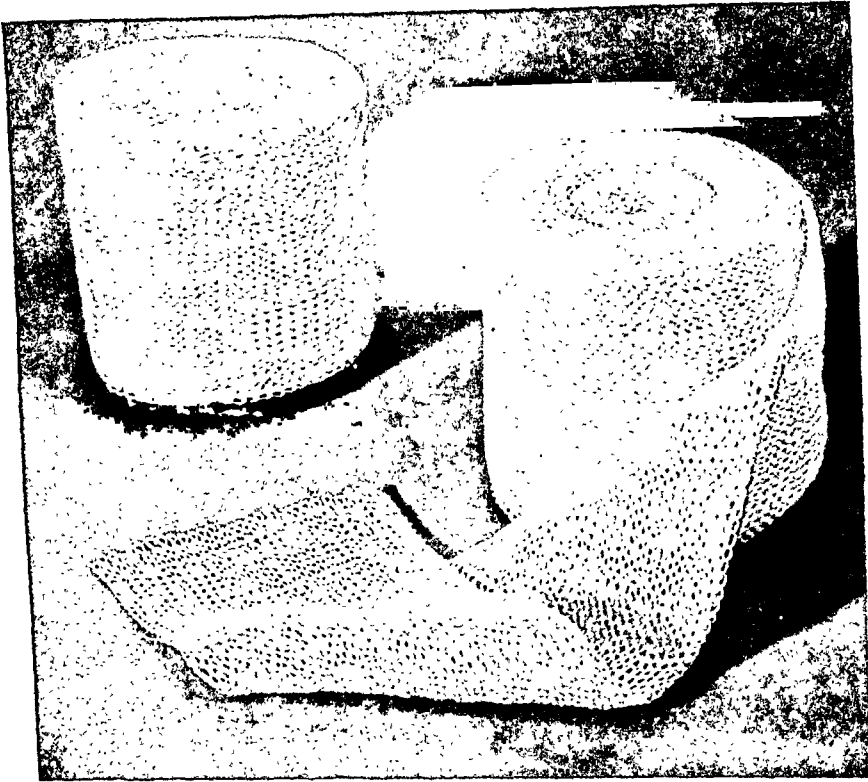


FIG. 1. The bandage is so knitted from glass and plastic fibers that it is flexible, porous, and elastic. Its strength comes from the truss-like design. The bandage is made in several widths and is packaged in cellophane for ease of handling and to keep it clean.

waterproof, plastic cast that in most respects met the requirements. The clinical effectiveness of this type of plastic cast has already been established by application to a substantial number of patients at the United States Naval Hospital, as reported by Kulowski, French, and Erickson.<sup>2</sup> In brief, the bandage then reported and the improved form to be discussed here is a knitted, all plastic bandage which, after being wetted with setting solution, hardens into a rigid cast.

The plastic bandage previously reported had many outstanding advantages, such

There were, however, a few drawbacks. For example, considerable care was required in its application, especially to avoid applying the bandage under tension, which sometimes led to contraction of the cast. The spraying on of the setting liquid required considerable time. By modifying the composition of the original bandage, these faults have been eliminated, and the desirable characteristics of the bandage have not only been retained but even bettered.

The modification which has made this major improvement possible is the substi-



FIG. 2. The glass plastic cast can be applied directly to the skin. Although very light, it is surprisingly durable and will withstand a good deal of wear. Soiling can be removed with soap and water. Aire-Lite can be sterilized in the usual manner in the autoclave, and since it can be applied close to or directly over the wound, a new approach to the treatment of wounds, burns, compound fractures, and plastic procedures is provided.



FIG. 3. T. B., Perthe's disease of the right hip. Radiograph taken through an Aire-Lite cast shows only slight obstruction to the rays. The great strength of the material makes it possible to hold major fractures, such as those of the pelvis or upper femur, with such a thin cast that clear radiographs can be obtained. The light weight helps the patient to become ambulatory even when wearing a spica cast.

tution of glass filaments of Fiberglas for the regenerated cellulose or rayon content. While various combinations of soluble

interior finish. The wetted cast sets and dries considerably faster than did the previously reported type. The completed

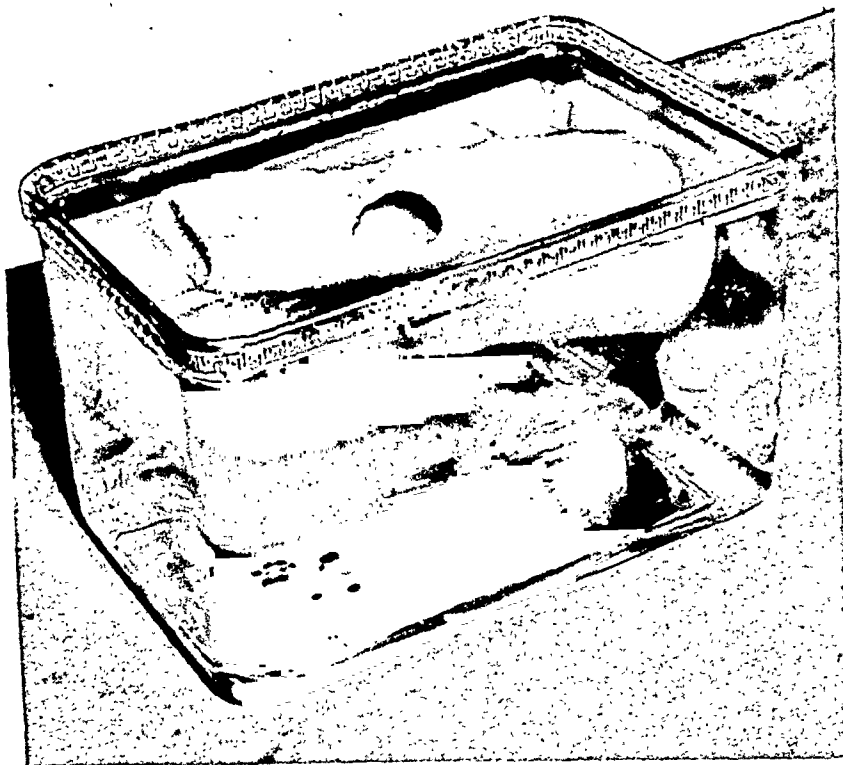


FIG. 4. Although the components of the bandage are slightly heavier than water, the porous structure of a cast of several layers entraps sufficient air to give it enough buoyancy to float.

plastics, with or without insoluble plastics, have proved successful, the preferred composition is cellulose acetate 80 per cent and glass 20 per cent by weight. Since both the glass and plastic filaments are finer than hair, smooth and flexible, the final knit bandage is soft, flexible, and elastic. By employing a special knitting technic and by regulating the physical-chemical pretreating process and the Fiberglas content, it is possible to capitalize on the elastic characteristics of the bandage so that it can be applied under tension without danger of subsequent contraction.

The bandage is wetted by immersion in the setting liquid just before it is applied. The action of the fluid on the entwined plastic and glass filaments fuses them into a rigid but smooth cast with a cool, silky

cast is light and porous. Although the component plastics are heavier than water, the structure of the cast is such that it will actually float in water. (Fig. 4.) The open mesh provides free circulation of light and air.

The setting or welding fluid is clinically a non-toxic solution with a slight winter-green odor that most users do not consider disagreeable. Although it is inflammable, no greater precautions need to be taken than for ether. The solution is compounded of chemicals with low boiling points to insure rapid evaporation. While various setting solutions can be used, the liquid used at present is a combination of acetone, methyl salicylate, and a group of hydrocarbons. The accurate formulation of this blend defines and regulates its action so

that the glass and plastic filaments will fuse together without the cellulose acetate being appreciably dissolved or softened. action on the skin of the hands from extensive use of the setting liquid, but the authors have had no difficulty. This is



FIG. 5. The bandage is easy to apply. As illustrated, the bandage is wetted by immersion in the Erickson Immersion Can. Since the bandage is elastic, it can be wrapped on under tension so as to conform to body contours.

This permits the cast to dry in a relatively short time.

Regarding possible reaction of the liquid on the body, there are two factors which make it safe to use, as verified by substantial clinical experience: First, the components have been carefully chosen for their non-toxic qualities and non-irritant characteristics, and second, the extreme volatility of the blend, coupled with the designed porosity of the cast, make it virtually impossible to maintain the liquid in contact with the body for more than a few minutes. As for the operator, there have been a few reports of a drying-out

easily prevented by the use of rubber gloves or the application of two or three drops of mineral oil to the hands prior to using the liquid.

There have been no reported allergic reactions from wearing of the glass plastic cast, and, judging from experience with plastics in other fields, their incidence should be extremely low. Cellulose acetate has been used in a host of ways in contact with the body, ranging from such items as lingerie and stockings to such articles as teething rings for babies, without appreciable reaction. Fiberglas, too, is quite inert as far as body tissues are concerned. For

example, it is being used without harmful effects in sutures, in surgical sponges, and as a burn dressing.<sup>3,4,5</sup>

application of the cast, stockinet is used, with one end left extended so that it can be held by an overhead support. If stocki-

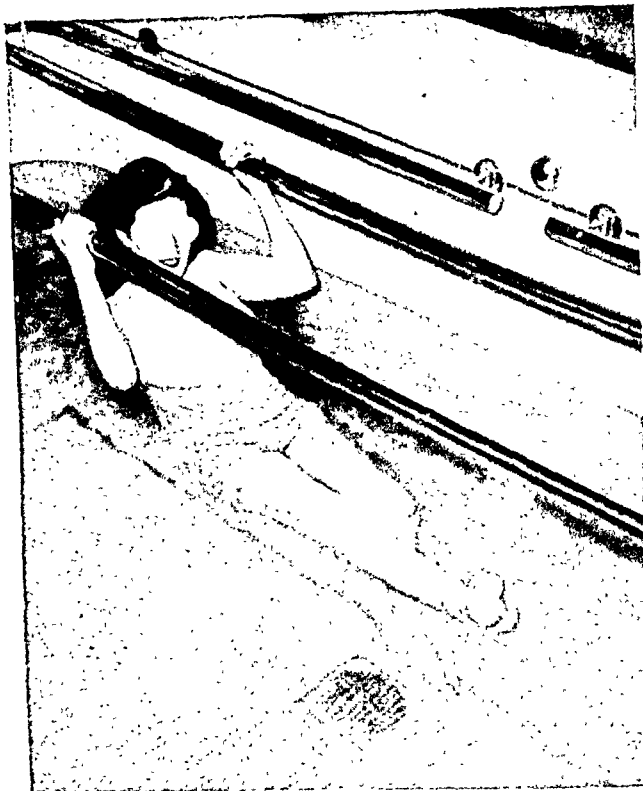


FIG. 6. Mrs. J. C., flail lower extremities from a recent attack of poliomyelitis. She is being taught to walk again through hydrotherapy. Later the foot portion of the cast will be removed, and the cast bivalved and applied only during walking exercises.

The question of inflammability of the completed cast is an interesting one. The glass portion, of course, is completely non-inflammable and the cellulose acetate burns reluctantly, especially when in the form of a cast. It burns less readily than clothes or bedding.

#### TECHNIC

The technic of applying the glass plastic bandage is simple and in a general way resembles that for a plaster cast. It can be quickly learned.

The part to be casted can be padded in the usual manner with sheetwadding. However, since the bandage is elastic, it can be so smoothly and accurately applied that padding is unnecessary. To have a good support for the extremity during

net is not desirable, the hand can be supported by means of finger traps. Thin strips of felt can be placed to assist later in wedging, bivalving, or removal of the cast. The bandage can be applied direct to the skin, and when properly applied the inside of the cast will be practically as smooth as a dinner plate. If the skin is dusted with talcum powder, the cast will not adhere to hairs or skin. Since the bandage can be sterilized by the usual autoclaving methods, it can be placed safely over or into open wounds.

The bandage is wetted by immersion in the setting fluid (preferably in a suitable device, such as illustrated in Figure 5). The bandage is immediately withdrawn from the liquid and with some tension it is wrapped in place. After the cast has been

completed, an ordinary elastic cotton bandage is wrapped over the entire cast. The cast is then shaped, smoothed down, and circularly rubbed with the palm for a few minutes, after which the cotton bandage is removed. Setting can be hastened by using a small hair drier.

*Disadvantages*, fortunately, are few and are not serious impediments to successful use. Their partial if not complete eradication appears a near possibility. The one disadvantage of any concern is that the setting time is slightly longer than that for plaster. However, this is largely compensated for by the fact that an Aire-Lite cast will dry out faster than a plaster cast. Recent improvements have considerably lessened the setting time, and, judging by the trend of continuing research, it will be still further reduced.

The cost of the plastic cast is at present somewhat higher than plaster. However, this difference in cost becomes negligible when all of the cost factors involved are taken into account. For example, with plaster, the need of extra linen and gowns, the laundering expense, the tracking and cleaning of floors and carpets, and the time and expense of frequent cast changes add up to a substantial amount. The outlook is for a continued lowering of the price of plastics as a result of ever increasing technological advances.

Another drawback has been that the process of molding the cast to correct such conditions as club foot or angulated fracture could not be readily done because pressure of the hands would interfere with evaporation. This situation has been met by allowing the elastic cotton bandage to remain in place at the site of the contemplated molding until the adjoining areas have set. When the desired degree of rigidity has been attained in the contiguous portions, the cotton bandage is removed. The usual molding or angular correction is then made, and the soft portion of the cast is left uncovered to harden in position of correction, in the usual manner.

*Clinical Advantages.* The glass plastic bandage can be used for all types of immobilization and for unusual therapeutic measures.

Since the material is waterproof, the patient can bathe, and the cast can be cleansed with soap and water. In the treatment of poliomyelitis, arthritis, hand and other infections, and most traumatic conditions, hot packs and hydrotherapy can be carried on without disturbing immobilization. (Fig. 6.)

Since the cast components do not absorb liquids or odors, involuntaries of senile or infant patients do not harm the cast and can be removed by washing.

Although an Aire-Lite cast weighs only one-fourth to one-sixth as much as a plaster cast, it is so strong and durable that changes are seldom necessary.

The elastic bandage is knitted with an open mesh and is so processed that it can be safely applied under tension to conform to every contour. It is as suitable for a little finger cast as for a large spica cast.

It is ideal for immobilization of hand and foot injuries and facilitates early return to work because the cast will not soften from absorption of liquids and can be readily cleansed of dirt.

The cast can be cut with an ordinary cast cutter, or, by applying the setting fluid or a softening cream, it can be cut with bandage scissors.

The cast is cool to wear, its porous structure admits light and air, and even when the cast is wet it does not block x-ray penetration. It can be used in the tropics because it does not absorb moisture and is not affected by humidity, molds, or fungi.

The bandage can be sterilized in the autoclave, and since it can be applied direct to the skin, numerous improved technics become possible. The preliminary clinical work in these fields shows promise and points to it as a useful addition to the armamentarium of the surgeon. The characteristics of the cast open a whole new avenue of therapy in such varied fields as

the treatment of compound fractures, osteomyelitis, burns, skin plastics, and orthopedic and urological reconstructions.

#### REFERENCES

1. ANDERSON, ROGER: New waterproof plastic cast. *Northwest Med.*, 43: 365, 1944.
2. KULOWSKI, J., FRENCH, A. M. and ERICKSON, H. R. Aire-lite, a new plastic medium of clinical immobilization. *Am. J. Surg.*, 66: 315-327, 1944.
3. SCHOLZ, ROY PHILIP and MOUNTJOY, PHILIP S. Fiberglas suture material. *Am. J. Surg.*, 56, 619-621, 1942.
4. LEWISON, EDWARD F. Rayable gauze as a factor of safety in surgical operations. *Bull. Am. Coll. Surg.*, 27: 39-40, 1942.
5. HURSHFELD, JOHN W., WILLIAMS, HAROLD H., ABBOTT, WILLIAM E., HELLER, CARL G. and PILLING, MATTHEW A. Significance of the nitrogen loss in the exudate from surface burns. *Surgery*, 15: 766-773, 1944.



AMPUTATION at the wrist should be planned, if possible, so as to save the thumb and a finger or other portion of the hand against which the thumb may be apposed. *Amputation at the wrist* prevents the proper fitting of an artificial hand and wrist mechanism without undue length, and *should be avoided*.

From "Principles and Practice of Surgery" by W. Wayne Babcock (Lea & Febiger).



# METALLIC FOREIGN BODIES AND THE ELECTROMAGNETIC LOCATOR\*

JOHN J. MOORHEAD, M.D.

NEW YORK, NEW YORK

IN the localization and removal of tissue-imbedded metallic foreign bodies there are always certain technical difficulties, and these depend mainly upon such factors as: (1) the source; (2) the site; (3) the size of the invader; and (4) the duration since infliction.

1. *Source factors* derive importance from the velocity, size, depth and consistency in terms of accessibility and actual or potential damage. Steel, iron, lead, copper, brass, tin and aluminum fragments are in order of frequency the most important and prevalent. Fragments from firearm sources usually penetrate more deeply than those from tools or other metallic materials. Bomb, grenade, shell, rocket, rifle, pistol and other military sources, because of their velocity and heat, may inflict damage disproportionate to their size, and also because of their tendency to rotate when they impinge upon tissues that change their direction and impede their progress. This applies especially to bomb and other fragments of irregular shape with sharp or jagged edges. Bullets and others of a cylindrical form usually present an entrance orifice relatively smooth and rounded, but always irregular at the exit orifice when of the so-called through-and-through or in-and-out variety (perforating wounds.) Fragments from tools (hammers, chisels and the like) produce, as a rule, an irregular orifice unless entering on their edged rather than their flat surface. Needles, surgical and sewing, usually penetrate smoothly and denote their site by symptoms directly proportionate to their impact, size and site. Shotgun lead pellets are generally multiple and their entrance site may be

smooth or ragged, depending upon their size, velocity and contiguity. Glass, unless with a lead content, fails to be delineated by roentgenologic examination, and penetration by wood fragments follows the same rule because it is unrecognized radiographically unless covered by paint containing a relatively large amount of lead, zinc or copper.

2. *Site factors* are important when the lodgment is close to or within important structures, as, for example, a viscus, strategic vascular or neural vessels, muscles, fasciae, tendons, joints and sometimes bone. A fragment in the palm, finger, foot, toe, cheek or neck may be much more important than the same sized invader lodged in thick muscle. Likewise, joint penetration may prove to be a potential source of danger. When the heart or lung is invaded the effects vary as between a fatality or relative quiescence because tolerance or intolerance follows the rule of being directly proportionate to the site and size of the foreign body. Invasion of the intestine, liver, kidney and other abdominal organs generally is a problem related to hemorrhage and peritonitis rather than that of the residual causative invader. Accessibility of removal is of prime importance as between the let-it-alone policy or removal in terms of initial or problematic effects. Many foreign bodies produce no effects whatsoever and remain quiescent throughout a lifetime; indeed, there are numerous instances in which the individual has no knowledge that an indwelling invader exists and with difficulty recalls a probable source of entry.

3. *Size factors* are of importance from the structure affected and the dimensional

\* From the Department of Traumatic Surgery, New York Post-Graduate Hospital.

relationship. This varies as between a tiny fragment in a strategic and usually mobile area, and a large fragment in a relatively unimportant and usually immobile (silent) region. For example, between eye involvement and invasion of the thigh muscles there are wide variables in terms of initial or subsequent implications. Lodgment within closed cavities (skull, spine, thorax, abdomen, joints) may not be the immediate source of concern to the patient or the surgeon, but the potentials are none the less possibilities or probabilities as to remote effects. The tendency toward encapsulation of an invader by fibrous tissue is well known and there is no question that this inclusion locking-up process often provides prolonged immunity and prevents activity in terms of an inflammatory or pressure reaction or change in position, this last producing the fear of "wandering," more often more bothersome to the patient than to the surgeon.

4. *Duration factors* are of importance in terms of the elapsed time since the receipt of injury; this post-traumatic implication is important in any aspect of traumatology.

The *initial* damage may manifest itself as hemorrhage; the *intermediate* effect may be in the form of infection; the *late* manifestation may produce pain, pressure, interference with function, or psychic signs of apprehension and fear because the invader may "wander" or produce "trouble later." Occasionally, the surgeon or the patient may anticipate subsequent abscess or inflammatory reaction long after the initial invasion; however, such an eventuation is clinically improbable after an elapsed period of six months. I have several patients who asymptotically retain foreign bodies as souvenirs of World War I and II conflict, and many in civilian life who are equally unaware that tool, bullet, buckshot and other metallic fragments are still indwelling. Many workmen are aware that a piece of metal became imbedded years ago and have forgotten the incident until roentgenologic examination for an unrelated, recent injury

recalls the bygone occurrence. Likewise, an ancient process is occasionally reactivated by a new injury, as, for example, a female patient of mine who harbored a sewing needle silently in the gluteal region for twenty-seven years until pain following a fall suggested roentgenologic examination. This disclosed a needle broken in two pieces which I removed with the aid of the locator, noting the characteristic black discoloration, incrustation, erosion and the surrounding fibrous tissue inclusion.

The cosmetic effect produced by swelling or nodulation is an occasional element, even when the invader has long been resident, as, for example, when the site is in the cheek, lip, eyelid, forehead, ear or some noticeable equivalent. However, in such an event, the exchange of the operative scar for the initial prominence must be weighed before advising removal.

#### GENERAL CONSIDERATIONS AND OPERATIVE INDICATIONS

For clinical purposes we can list invaders as being *important*, potentially *dangerous*, or *unimportant*. Further, foreign bodies may be *superficial*, *intermediate* or *deep*, irrespective of their source, site or size. Multiple imbedded fragments are important in terms of their diverse effects and the probability of safe removal of all or some of them.

In general, it can be said that operative procedures are indicated if any invader is actually or potentially damaging or dangerous, and if the removal attempt does not add to the gravity of the situation. This is equivalent to stating that often a let-alone is safer than a do-something policy. Further, the decision is frequently postponed until the possessor becomes aware of trouble because of pain or interference with function. Then, again, a later and more complete roentgenologic survey may cause the surgeon to advise operation, especially if there has been a change in the position of the invader. The fear of direful consequences is often aroused in the patient by some fanciful account of the

meanderings of a metallic fragment that years ago entered the sole of the foot, for example, and finally reached the groin or even the heart. The travels of needles as recounted by some newspapers and magazines are usually far more romantic than anatomic. The clinical fact is that the vast majority of imbedded fragments remain at their original site, imprisoned in a fibrous encapsulation. However, it cannot be denied that wandering does occur, and this is more prevalent in a mobile than an immobile site, and more common with cylindrical objects as compared with flat objects. Needles and materials of this general size and shape will infrequently change position if imbedded in an area subjected to repeated motion, especially if residing under the fascial coverage of thin, elongated muscles, as in the forearm, arm and leg. When cavities are involved and the invader is more or less afloat or unanchored, the chances for change of position may be very great. In one patient a needle had been located by x-ray, in the anterior part of the knee joint not far from the place of entry. Despite the aid of the locator, I could not find it; later, x-ray exposures showed it to be in the posterior part of the knee and this site was verified by the locator and removal was then easy. Broken wires, nails, pins and screws used in the treatment of fractures are known to have wandered far afield. In some reported cases they were inserted near the shoulder and subsequently were located in the thoracic region. Others escaped from the hip area and penetrated into the pelvis and even involved the bladder. However, these events are clinically exceptional, and it can again be confidently asserted that the general rule is for a foreign body to remain permanently domiciled or interred in its original resting site.

Therefore, operative removal depends upon the factors dangerous or damaging in respect to the immediate, intermediate or late consequences. However fixed these surgical indications may be, we are often confronted by the patient's fear complex

and this, as stated, may compel an attempt at removal. Usually this problem arises in connection with compensation and allied legal cases; and my experience is that the average patient prefers removal to non-removal if assured that the operative procedure is reasonably safe and certain.

#### METHODS OF LOCATING FOREIGN BODIES

Clinical signs, such as site of entry, swelling, local tenderness, local induration, pain on motion and pressure are valuable, but often disappear after a lapse of a few weeks. Occasionally, the invader remains palpable indefinitely and in some cases a muscular contraction may make it visible.

Radiographic examination is, of course, the determining factor, as disclosed by fluoroscopy or radiography. The former is less reliable than the latter. Repeated fluoroscopic examination may be harmful to the patient and the observer, hence, caution is needed as to frequent exposures.

Film examination should be in several directions, making certain that the axes are predetermined so that the operative approach will depend upon the liaison between the surgeon and radiographer. It is equally important to have films made in the axis on which the patient is lying during the proposed operation, and following same the patient is to be moved or transported with the possibility that the object of the search may shift if the invaded area is unduly disturbed.

The usual films are made in two axes, as a rule, anteroposterio and side-to-side, so that the site and depth determination may be fixed at right angles. However, oblique axes, as stated, are often needed, so that instead of the usual North to South and East to West directions, we may also have other compass markings. Another delineation is clockwise, as from 12 to 6, and 3 to 9; or from 2 to 8 and 10 to 4. Various opaque markers are often placed on the exposed surface and their site is noted by iodine or other staining, or by ink or indelible pencil. Similarly, wire mesh of known interspacing may be used and less often, a needle or probe is introduced so

that a fixed line of approach may be indicated. In open wounds opaque material is sometimes injected along the suspected tract, but this is generally an unreliable method unless the route is quite narrow. Location by x-ray tube-shift, the double exposure and the triangulation process are probably the most reliable of all, if made by an experienced radiologist and clearly interpreted to an understanding surgeon. In some cases fluoroscopic search with the patient on the operating table is the chosen method, but this is obviously quite troublesome unless the set-up is unusually replete and complete. However, despite very accurate preoperative x-ray aid, it is frequently impossible to retrieve the offender, and this usually is because the operative procedure shifts or displaces the object. Retraction and palpation are the two chief factors in displacing the fugitive, especially if the fragment is small, flat, mobile, or even when invested by fibrous tissue difficult to distinguish visually or digitally from normal markings or the nodules from ligated vessels. Hence, the search should be by clean dissection, when possible, with a minimum of palpation and retraction. In recent cases especially, a bluish or dark discoloration may furnish a clue; and in the case of large fragments, a cicatricial band may be suggestive.

My own experience has been that an apparently easy situation sometimes proves very hard; and the reverse also applies, with the result that assurance of success is usually problematic. Magnets, special probes and sundry devices are often unavailing in the solution; and until the locator device was perfected, success still remained in the problem stage. The precision finder, which will now be described, has been used by a number of surgeons under trying conditions and is worthy of extended use.

#### THE LOCATOR

This is an electromagnetic device perfected for me by an ingenious inventor in

the electrical field, Samuel Berman. He was formerly in the electrical engineering department of the New York City Transit System, of which I am the Medical Director. The impelling need for an improved searching device arose from the frequency with which employees of the System required surgical attention for the removal of imbedded metal accidentally acquired during the course of their employment.

The initial model was first successfully used by me at the Reconstruction Hospital in November, 1941, to remove metal fragments from the ankle region of one of the policemen injured in the World's Fair bombing incident of July 4, 1940. Incidentally, this victim had 167 fragments imbedded in the front of his body from scalp to toes, and most of these small objects still remain *in situ*. This original locator was brought to Hawaii to be demonstrated at a series of lectures given by me as a guest of the Honolulu Medical Society. However, less than four days after my arrival, the fateful Sunday of December 7, 1941, the Pearl Harbor Attack, gave abundant opportunity for proving the value of the apparatus at the Army Tripler General Hospital, where I was soon assigned to active duty as Colonel, Surgical Consultant. Subsequently, several of the Army surgeons, on two successive days, retrieved bomb and other fragments from more than a score of casualties. My own most impressive result while there was in the removal of a machine gun bullet imbedded between the lumbar spine interspaces, causing partial paralysis of the lower extremity and the bladder.

The present apparatus represents many improvements over the original models, and it has now been considerably improved so that more than ever it resembles a portable radio in appearance and action.

Essentially, the device has a search *probe* (present model has two of differing sizes), an instrument board with several *knobs* for circuit adjustment and a *dial* indicator to register the approach of the probe to the

foreign body. Sterilizable rubber envelopes are applied over the probe when used within the wound. A built-in amplifier affords very high sensitivity and a small loud speaker supplements by sound the visual indications of the dial. A red panel light indicates when the plug-in wire is connected and the ground wire is attached to a convenient ground (water pipe, steam pipe, etc.). The apparatus is set up in a few minutes and is ready for use wherever electric current is available. The present model operates on 110 volts A.C. only, but special models can be built for operation on 110 volts D.C., 6 volt storage battery, or on dry batteries. (Fig. 1.)\*

*Sensitivity to Various Metals.* The locator is extremely sensitive to the magnetic metals (iron or steel). A mass of  $\frac{1}{2}$  mm. diameter is readily detected from a distance of 2 mm.; an ordinary pinhead (about 2 mm. diameter) from a distance of  $\frac{1}{2}$  inch; a full length common sewing needle from about  $1\frac{1}{2}$  inches; broken sections of stainless steel hypodermic needles from  $\frac{1}{4}$  inch to about an inch depending upon their length and composition (such needles are generally of rather low magnetic susceptibility). Platinum needles and some non-magnetic alloy needles now in use are not detectable with this apparatus. The maximum range for large masses such as hemostats, etc., is about 4 inches.

The sensitivity of the present apparatus to non-magnetic metals (copper, aluminum, brass, lead, etc.) is relatively slight, although still useful at times. A copper one-cent piece or a .45 caliber lead bullet is detected from a distance of about  $\frac{1}{2}$  to  $\frac{3}{4}$  inch; a silver twenty-five-cent piece from a little over an inch. Small vitallium screws are not detected. Improvement in this field is proceeding rapidly and laboratory models are now available with a relatively high sensitivity to non-magnetic metals. These will detect a .22 caliber lead bullet from about  $\frac{3}{4}$  inch, and a .45 caliber lead bullet from nearly two inches.

\* Since this article was written a new model has been devised which will operate on A.C. or D.C. current or a storage battery.

These experimental units have already been used successfully in the surgical removal of small caliber lead bullets, but it cannot yet be foretold when their production will be possible.

*Method of Using the Locator.* After the apparatus is set up, the probe is passed over the suspected region and the point giving the maximum response is marked on the skin. The usual method for quickly determining the surface localization is by moving the probe successively over the site from two directions at right angles, marking lines on the skin to coincide with the two "peak" positions of the probe. The intersection of the two lines is the surface localization. It is further possible to determine the axial alignment of an elongated foreign body, such as a needle parallel to the surface, by the fact that a much greater response is obtained when the probe is parallel to the foreign body than when it is at right angles to it. Accordingly, by rotating the probe over the marked spot the axial alignment of the foreign body is determined by the probe alignment which produces the maximum indication.

*Depth Estimate.* Two methods are available for estimating the sub-surface depth. A rough estimate may be obtained directly by noting the maximum meter reading at the marked spot, and moving the probe laterally along the skin surface until the reading drops to one-half that value. The distance moved laterally is roughly equal to the sub-surface depth. For example, if a maximum reading of 7 is obtained over the marked spot, move the probe laterally along the surface until the reading falls to  $3\frac{1}{2}$ . The lateral distance between the probe and the marked spot is then roughly the same as the sub-surface depth of the foreign body.

A more accurate method is to choose a metal sample which closely matches the foreign body in composition and in dimensions as viewed in the x-ray film. Note the maximum reading of the meter over the marked spot on the patient and, holding the matched sample in the hand, approach it with the probe until the meter reading

is the same as over the marked spot on the patient. The distance between the probe and the test object is then the same as the

val between radiography and operation. Likewise, the involved area should be kept as immobile as possible in the immediate

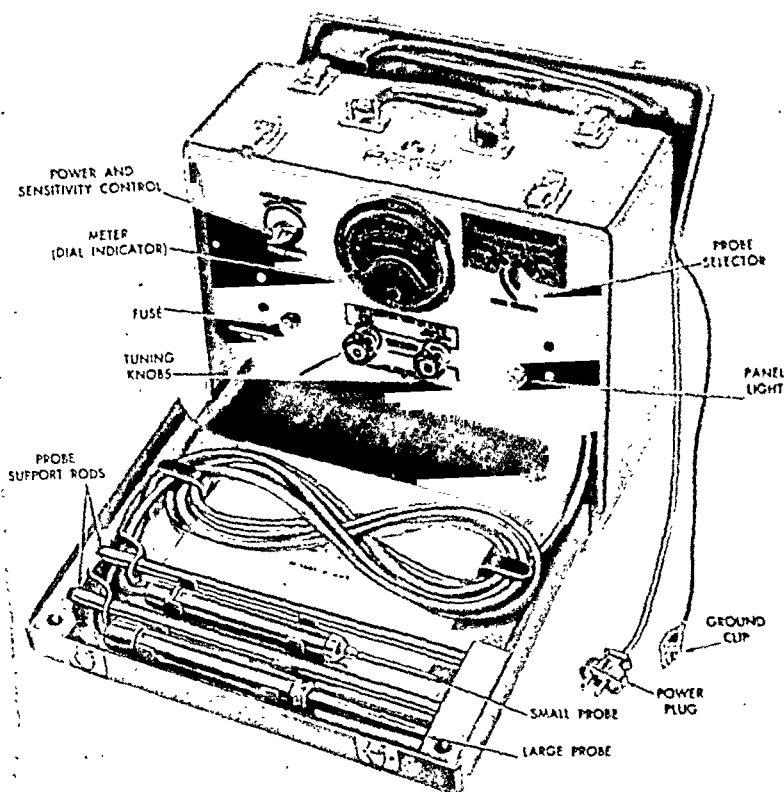


FIG. 1. Locator showing the various elements in the carrying case; size 15 by 13 inches; weight 25 pounds.

sub-surface depth, accurate to within a tenth of an inch. Since electromagnetic waves penetrate most solid matter (bone, soft tissue, rubber, glass, etc.) with practically the same degree of freedom as air, the accuracy of this test is unaffected by the intervention of tissue in the patient.

#### OPERATIVE TECHNIC

Obviously, no attempt at removal should be made in the presence of infection unless the foreign body is responsible for the infective process; in effect, the invader then acts like a sequestrum in osteomyelitis.

Preliminary roentgenologic examination, as stated, should be as close as possible to the time of operation, especially if the area invaded is of the mobile type or a cavity is involved. This overcomes the possibility of wandering or shifting in the time inter-

preoperative period, hence, splintage is often valuable. The patient should be placed on the operating table in the same position as when on the x-ray table, and the more experienced the operator the closer will be the liaison with the radiologist.

Before the preoperative cleansing is done, the locator determines the surface location of the invader and this spot is marked by an indelible pencil or other indicator. Personally, I prefer anesthesia by pentothal, followed or reinforced by an inhalant, if necessary. Local infiltration may be used in certain cases, however, as, for example, in a finger or some other easily delimited area. Usually, a tourniquet is unnecessary. The locator is, of course, no source of explosive danger when an inhalant anesthetic is employed. The area involved should be raised 8 to 10 inches above a metal-topped table.

The incision may be straight or curved (I prefer the latter) and is centered over the previously marked spot. The extent

directs us to proceed further and leads to a depth beyond view, my practice is to use a thin artery clamp, the point of which

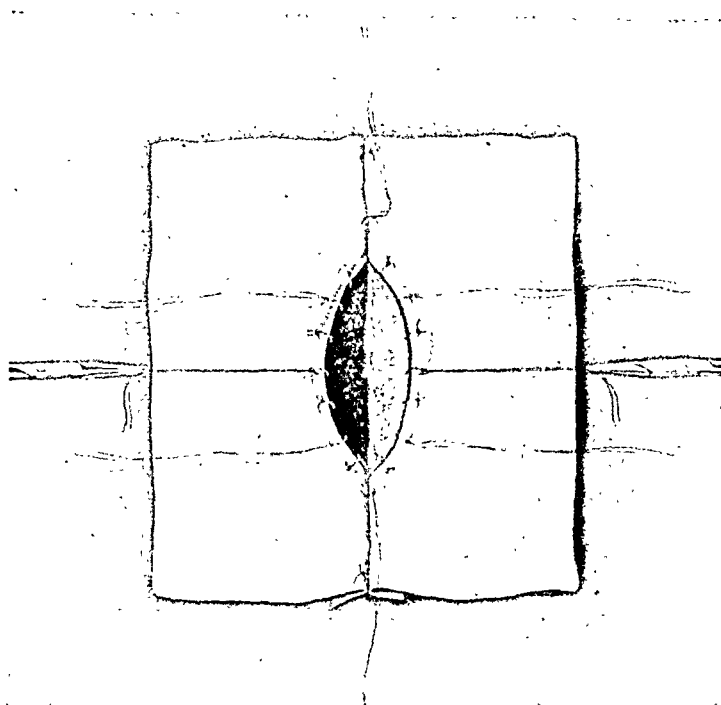


FIG. 2. Method of draping the operative field showing long sutures to be used for retraction, thus avoiding magnetic effect from metallic retractors.

of the initial exposure, naturally, depends upon the site, size and depth of the invader. Bleeding vessels are controlled by fine ligatures. The field is suitably protected by fastening the drapes to the skin by sutures, leaving uncut about six inches of some of these to act as retractors so that there will be no extraneous metallic material to interfere with the action of the locator. (Fig. 2.) The probe of the locator, covered by the sterile rubber protective, is now introduced into the wound and its point is moved about until by the dial and sound registration we are directed as to the further approach. We follow the lead thus given by sharp dissection, avoiding, if possible, any palpation or retraction within the wound cavity. If retraction becomes necessary, wooden tongue depressors or special plastic retractors are used, in addition to the threads previously attached. If now the sterile locator probe

is placed alongside the tip of the probe before the latter is withdrawn. Usually, I fasten this artery clamp into a bit of tissue at the site indicated so that a better clue is provided. A finger now cautiously introduced in this region may palpate the fugitive; if not, further incision and exposure in this area proceeds. The sterile probe is reintroduced if this additional route proves unavailing and, thus, by repeatedly following the direction indicated by the locator, the invader is finally unroofed and extracted. Instead of the artery clamp, it is feasible in some cases to use a wooden applicator which is placed at the tip of the probe as the latter is withdrawn. As stated, wide or deep retraction is very prone to displace the hidden object, and indeed palpation or rough sponging may act likewise. The field should be kept as dry as possible, and often a suction apparatus in a cavernous region may be

helpful. With patience, adequate exposure and proper use of the locator, the percentage of failures should be very small.

lem. In one case reported to me the radiograph failed to show any foreign body, but the locator indicated a tiny fragment, and

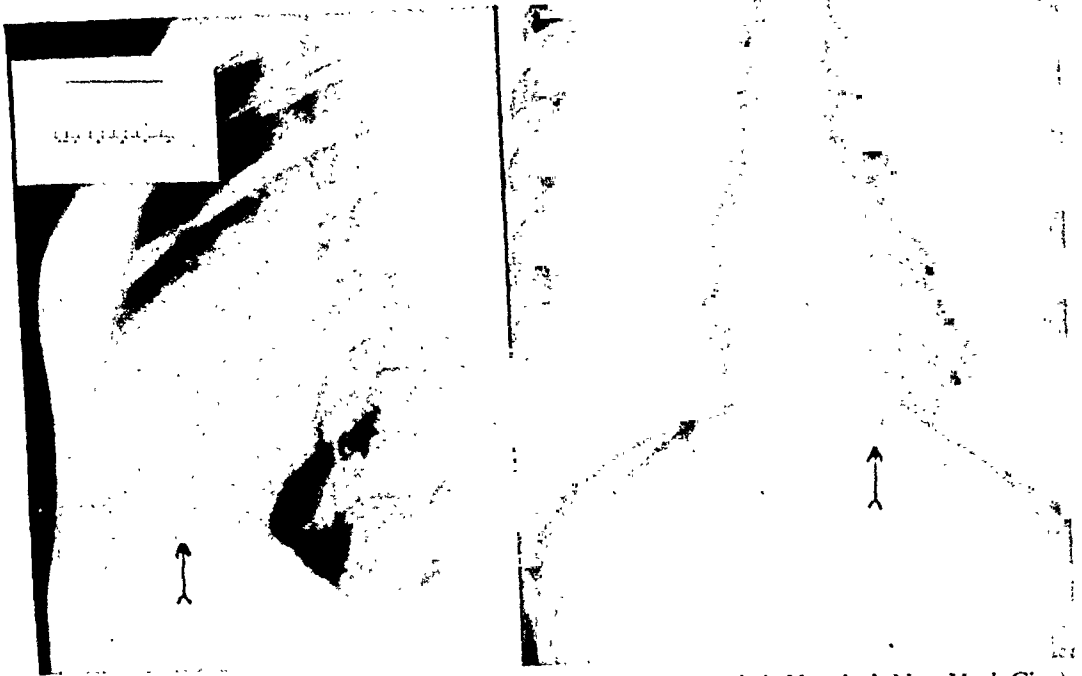


FIG. 3. Needle in the heart. Patient of Dr. A. E. W. Ada (St. Luke's Hospital, New York City).

*Closure of the wound* is by standard procedures; and if there has been a prolonged search or there is any question of infection, a small drain may be inserted between the interrupted, non-absorbable skin sutures, which are removed within three days.

A heavy dressing, with or without splintage, is an additional safeguard, especially when the source of the penetration is suspect. The use of a sulfonamide or penicillin within the wound is a matter for the surgeon's judgment.

The preoperative use of tetanus anti-toxin in suspicious circumstances (as in bullet wounds) is a necessity and if more than two weeks elapse since the initial anti-toxin was administered, it may be prudent to administer an additional pre-operative dose.

#### FOREIGN BODIES IN SPECIAL AREAS

*Eye cases* have yielded many locator successes, and in this region the difficulty of accurate localization has always been an especially important and puzzling prob-

lem. In one case reported to me the radiograph failed to show any foreign body, but the locator indicated a tiny fragment, and

this ophthalmic surgeon successfully removed it by this device. In this area the difference of a few millimeters often determines the outcome so that super-accurate localization is more necessary here than elsewhere.

*Heart cases* have thus far afforded only one notable opportunity, this being a patient of Dr. Alexander E. W. Ada, of St. Luke's Hospital, who successfully removed a needle from the left ventricle by the aid of the locator. (Fig. 3.) This was one of the most dramatic operations I ever witnessed, and this patient was subsequently shown at the New York Surgical Society, March 8, 1944.

*Intrathoracic cases* have been relatively numerous and the facility with which the locator probe can be introduced has been of signal aid in localization. (Fig. 4.)

*Intraspinal cases*, likewise, have been notably successful and in this region the difficulty in localization and removal of broken needles has long been recognized. (Figs. 5 and 6.) In such cases particularly,



palpation must not be resorted to, as the needle may easily be pushed deeper, even into the spinal canal. Adequate exposure,

approach as the operation proceeds. This dial reading within the wound is compared with that of the sample from time to time,



FIG. 4. Needle in the lung. Patient of Dr. J. M. MacKellar (Englewood Hospital, Englewood, N. J.).



FIG. 5.

FIG. 6.

FIGS. 5 AND 6. Broken intraspinal needle. Patient of Dr. J. K. Skiles (West Suburban Hospital, Oak Park, Ill.).

good light, a suction apparatus, and everything that will aid visual inspection with a minimum of tissue manipulation should be employed. It has been found advantageous to sterilize a duplicate sample section of the same type needle and keep it at hand on a sterile sponge for checking the proximity of

and in this way the surgeon knows when he is almost contacting the end of the needle. Final approach should preferably be made from the side rather than from directly above. This caution applies to the manipulator of the search probe, as well as to the surgeon.

In addition to the surgical possibilities, there is frequently the prospect of a malpractice suit, and indeed this is a feature

insulin, and in this group the locator has been of frequent service.

Gynecologic cases in which a surgical

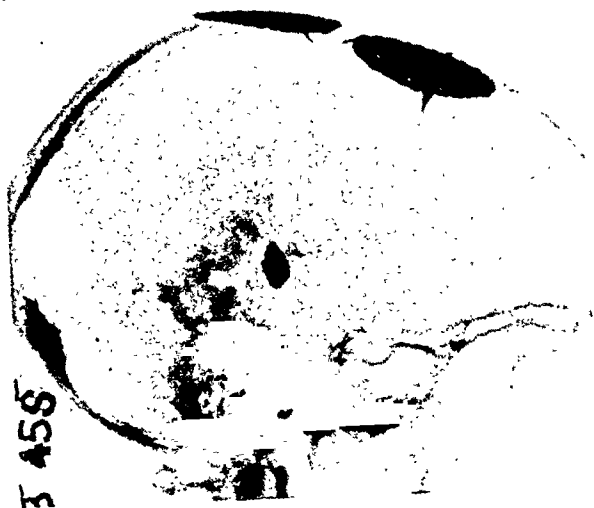


FIG. 7.



FIG. 8.



FIG. 9.

FIGS. 7, 8 AND 9. Shell fragment in mid-brain, showing size, site of entry and place of lodgment.

common to many operations when a needle has been broken or an instrument has been left in a cavity.

*Hypodermic needles* have been broken and left imbedded in various regions, some of them by diabetics who self-administer

needle has been broken in performing a perineorrhaphy, have also afforded several opportunities to prove the worth of the apparatus.

*Intrathoracic and intra-abdominal cases* as yet have not been featured, but in many

cases of foreign bodies in the respiratory or gastrointestinal tract the device should prove useful. This should apply especially

Masson has very recently removed a shell fragment deeply imbedded in the midline of the brain of a soldier. (Figs. 7, 8 and

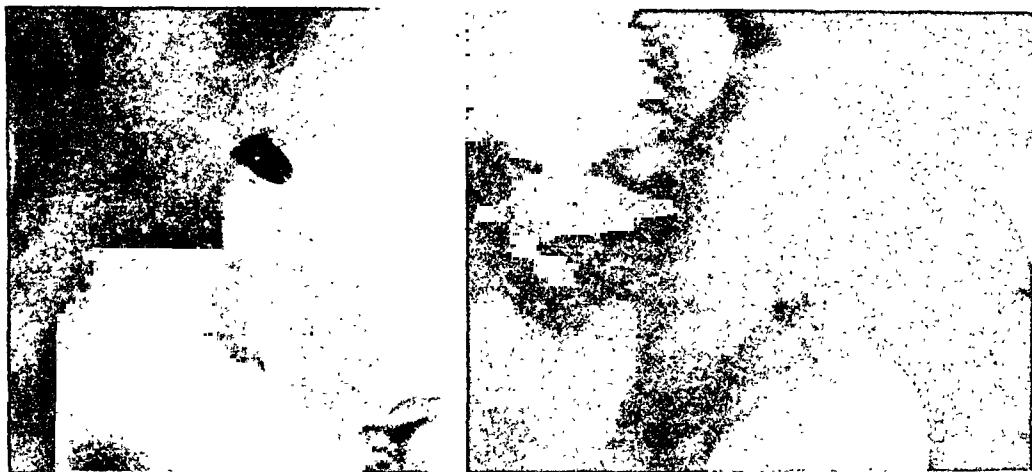


FIG. 10.

FIG. 11.

FIGS. 10 AND 11. Bullet in gluteal region.

to the location of pins, needles or other metallic objects in the trachea, bronchi, lung, esophagus, stomach and intestine. Obviously, the size and depth of the invader will be determinative. However, there is no question that the locator can be helpful in this troublesome group, either before operation or when the involved area is exposed so that the probe can be introduced. It probably is feasible to attach a steel segment to intubation apparatus, such as the Miller-Abbott device, to indicate more accurately where the distal end of the tubing resides and thus avoid the necessity for repeated roentgenologic examination.

*Neck cases* assume importance because of the mobility of the so-called ribbon muscles and the contiguous respiratory and deglutitory mechanism. In one case a fragment was lodged in the region of the thyroid, according to the radiographic interpretation, and this patient was to have been used by me for a demonstration of the locator. However, the day before the prospective operation the patient coughed up the offender.

*Brain cases* also provide another field in which the sterile probe will become actively helpful.

At the Neurological Hospital Dr. C. B.

9.) This neurosurgeon asserts that without his previous favorable experience with the locator he would not have ventured to operate on this battle casualty. In this case, the cauterization of bleeding vessels obviated the use of clamps which would have interfered with the action of the locator.

*Military cases* have been numerous, but, obviously, details as to many of these are not yet forthcoming. The rule in front line activity is to remove the missile at the time of the initial débridement, if feasible. However, if the condition of the patient or time does not permit, the removal of the invader is postponed. Thus, in the front line zone, in the base zone and in the post-war period there will be many casualties in which extraction of foreign bodies will be necessary. In the sorting or triaging of military casualties a fluoroscopic or radiographic examination is routine when circumstances permit. However, by the use of the locator large groups of suspects can be quickly sorted to determine the presence of residual fragments and, thus, the triaging can be accomplished with great speed and accuracy. (Figs. 10 and 11.)

It must be remembered, however, that because the effective range of the locator

is considerably less than the x-ray, a negative result with the locator is by no means conclusive of the absence of a foreign body. A positive indication, on the other hand, not only determines the presence of the missile instantly, but localizes it at the same time with utmost accuracy.

To date, the greatest known mass use of the apparatus was after an explosion in which 202 foreign bodies were removed from fifty-five patients within two days.

Priority limitations until recently permitted the civilian use of the apparatus only on a lending basis, but now the manufacturers\* have a limited supply available.

The combined use of x-ray and the locator finding device has greatly reduced the incidence of failure and has brought the search for imbedded metallic material into the zone of assured success. To date, in 173 cases there has not been one negative result when this device has been used by some eighty-three surgeons in the metropolitan and adjacent areas. In many cases the locator was successful after previous efforts were unavailing. So far as is definitely known, there is no other available apparatus activated on the same principle, although in Germany there is said to be a device based on radio activity which has been successfully employed by military surgeons. The English, according to recent correspondence with me, have been using, with indifferent results, an apparatus similar to that said to be employed by the Germans.

A further development of the locator may be successful in extracting the foreign body after it has been located.

#### CONCLUSIONS

1. A device is described by which metallic foreign bodies can be located

\* Waugh Laboratories, New York City.

more accurately, thus supplementing the use of x-ray localization.

2. This apparatus is of special service when the suspected area has been exposed at operation, notably because the pre-operative x-ray localization is then less reliable, inasmuch as the fugitive is often displaced by the operative procedure.

3. The operative technic is described and special caution is enjoined so that palpation and retraction may not displace the object sought.

4. The device has a unique field in locating foreign bodies in difficult sites, notably the eye, heart and lung.

5. A precision approach is possible with the locator so that the operator can now have a greater assurance of success outside of and also within the operative area.

6. There is a wide field for this device in civilian, as well as in military, surgery, and in the post-war period its zone of usefulness will greatly increase.

7. Before using, it is essential to test the device by locating foreign bodies purposely imbedded in modeling clay, sponge rubber, sections of meat or other materials. Like any other precision instrument, the locator responds best when used with knowledge, skill and experience. It can be confidently asserted that failures are chargeable to the user more than to the apparatus because the underlying scientific principles involved are unerringly accurate.

#### REFERENCES

- Lancet*, 2: 517-18, 1941.  
*Zentralbl. f. Chir.*, 67: 2338-2344, 1940.  
*München. med. Wchnschr.*, 88: 353-380, 1941.  
*Chirurg.*, 13: 207, 1941.  
*Ibid.*, 13: 211, 1941.  
MOORHEAD, J. J. *J. A. M. A.*, 121: 123-125, 1943.  
BAILEY. *Surgery of Modern Warfare*. 3d ed., p. 299, 1944.  
HOLMAN, E. *Ann. Surg.*, 119: 1, 1944.  
PARKES, M. *Am. J. Surg.*, 65: Sept., 1944.  
THORPE, H. E. *J. A. M. A.*, 127: 4, 1945.  
GLASER, OTTO. *Med. Phys.*, p. 725-727, 1944.



# EMBEDMENT OF A VITALLIUM MANDIBULAR PROSTHESIS AS AN INTEGRAL PART OF THE OPERATION FOR REMOVAL OF AN ADAMANTINOMA\*

LEO WINTER, M.D.,

Surgeon in Charge, Oral Surgery, Bellevue Hospital

JACOB C. LIFTON, D.D.S.

Attending Orthodontist, Hospital for Special Surgery

AND

ARTHUR S. McQUILLAN, M.D.

Director of Surgery, Misericordia Hospital

NEW YORK, NEW YORK

UNFORTUNATELY there are conditions in the mandible, where diseased and adjacent tissue must be removed, regardless of disfiguring facial sequelae. It seems only such sacrifice would save or prolong the patient's life. An analogous situation is to be discussed. It is of especial interest, because at the time of the excision of an extensive adamantinoma, and as an integral part of the surgical procedure, a mandibular vitallium prosthesis was inserted and attached to the remaining mandibular segments. The appliance was substituted for the removed bone and was itself embedded or buried within the soft tissues. Thus, some of the usual dreadful consequences following a radical resection were obviated.

"An adamantinoma is a locally malignant tumor of the jaw. Adamantinomas may be solid or cystic or a combination of both and are sometimes called multilocular cysts, multilocular cystomas, or ameloblastomas. A solid adamantinoma is slow growing, occurring more often in the mandible than in the maxillae, is well encapsulated and does not metastasize. The cystic adamantinoma develops from the solid adamantinoma by cystic degeneration of the epithelial portion of the tumor. Because of this, epithelial cysts and bubbles are formed which are usually found in the body of the jaw. Originally there are many separate cysts present and the adamantinoma, therefore, shows an

uneven lobulated contour. These cysts are of various sizes, ranging from small cystic cavities to extremely large ones, even extending through the entire mandible. These tumors may appear at any age, but they usually occur between the ages of 20 and 30 years."<sup>1</sup>

## CASE REPORTS

L. L., a female, aged fifty-five years, was referred to us. She complained of intermittent, excruciating pain in her mandible. The lower third of her face was distorted, her mandible seemed to be irregularly prognathous. Although she had been edentulous for many years, her lower lip did not shrink. (Fig. 1A.)

Her medical history dated back twenty-six years to 1918, when a small lump which did not cause her any pain was noticed on the right side of the mandible. This was treated and observed for a few years. However, ten years later (1928), the patient did complain of pain on the same side of the mandible which proved to be a recurrence of the previous lesion. To treat this condition, an extra-oral operation was performed. Then three years elapsed (1931), when a large fluctuating diffuse mass which extended from the anterior border of the right ramus to the left premolar region had to be excised. The clinical diagnosis was "multilocular cystic tumor." To supplement the surgery, several courses of radium radiation and roentgen therapy were administered. Two years later (1933), a bluish cyst 1 cm. in length was noticed in the right sublingual gland. An x-ray examination disclosed another recurrence. The procedure followed in 1931 was repeated, i.e.,

\* From the Fourth Surgical Division, Bellevue Hospital, New York City.

conservative intra-oral surgery supplemented with radium radiation and roentgen therapy. The previous treatment notwithstanding, in

formations divided by bony trabeculae and multiple bubble formations. The growth involved the entire body of the mandible from



FIG. 1. A, front view of patient showing irregularly prognathous mandible. B, moulage of patient with door-like sections opened to show the intra-oral swellings.

February 1943, the patient again complained of intermittent pain in the mandible to the left of the symphysis. An oral examination revealed a small cystic swelling which seemed to be continuous with and part of a larger mass. The larger mass occupied the submental region immediately to the right of the mid-line. The x-ray report in July 1943, comparatively described the lesion as "considerably increased in area."

In the winter of 1943, our oral examination revealed an edentulous mouth. Her tongue was displaced distally. The entire mandibular alveolar ridge was considerably swollen and irregularly distorted. (Fig. 1B.) The mass was widest in the median line beneath the frenum linguae to the mucolabial fold, measuring 32 mm. in diameter. It narrowed slightly toward the canine regions, then extended laterally in both directions to approximately the second molar region on the left measuring 22 mm. from the lingual surface to the mucobuccal fold, while on the right, the swelling continued to the retro-molar region measuring 27 mm. in the same linguobuccal direction.

Our roentgenograms revealed multiple cystic

the crest of the alveolar ridge to its inferior border. In some regions, notably the anterior, there was no visible cortical bone. The picture was typical of adamantinoma of mandible. (Figs. 2A and 2B.)

Previous conservative surgery apparently was only temporary in its effectiveness. Obviously, the roentgen therapy and radium application did not result in the anticipated cure of the tumor, or prevent its recurrence, or limit its growth. In view of the extensiveness of the neoplasm, there was no choice but a radical surgical operation.

We realized that with the removal of so much mandibular bone, the facial and neck muscles would lose their basic support, and there would be a collapse of the lower part of the face. Thus, their normal co-ordinated function would cease, and thereby would seriously hamper such essential functions as breathing, mastication, and talking. These mutilating consequences would produce a caricature-like physiognomy. The prominence of the face and its obvious nakedness would further aggravate the situation. Moreover, we were fully cognizant that in no part of the

human body does alteration in contour cause an individual more despondency than its occurrence in the face.

be borne in mind. For other patients,<sup>2</sup> the most trying period followed the resection, when they recognized their deformity. The



FIG. 2. A, roentgenogram of left side of mandible showing the extension of adamantine formation to approximately the second molar regions. B, roentgenogram of right side of mandible revealing multiple cystic formations, divided by bony trabeculae and multiple bubble formations. Note there is no cortical bone in anterior region.

Therefore, a truly realistic and positive approach for the care of the patient was impelling. A keen appreciation of her mental health as well as the surgical hazards had to

depression continued until they were persuaded that a prosthesis would help them. During that interim, their anguish and dejection were greatest, the mental and physiological adjust-

ment most difficult. To obviate such undesirable conditions, something had to be anticipated to be used at the time of the operation which could preclude facial collapse, and thus maintain facial contour and regional functional constancy.

To accomplish such an objective, a thorough study was undertaken. Impressions of the maxillary and mandibular jaws, a plaster facial cast, and a facial index were taken. A special effort was exerted to include not only the full oral extent of the tumor, but also the adjacent tissue. With the facial index giving the relationship among the various parts, i.e., maxillary and mandibular models to the face and head, a composite moulage was made. (Fig. 1B.) Thus a reproduction of the patient was had which could be studied from different planes, and whenever desired. Similarly, additional information and guidance were furnished by the various roentgen plates.

Any device to be made from the foregoing study had to possess not merely adequate physical properties and physiological potentialities, but most important, it had to have the overall purpose of serving as an essential psychic prop.

As prerequisite, the prosthesis should: (1) be completed prior to the operation and be ready for insertion at the time of operation with a minimum of adjustment necessary; (2) be of a material tolerated by tissues in order that it could be embedded permanently within them; (3) take the place of the removed bony tumor and adjacent bone; (4) be attachable to the remaining healthy mandibular segments; (5) stabilize the remaining parts so as to enable them to function as a continuous single united bone; (6) be strong enough to support and withstand the stress of the musculature previously attached to the diseased bone; (7) possess provisions for the attachment of those muscles to it, and (8) possess adequate bulk for facial contour, but of limited dimensions to permit the complete closure of the surrounding mucous membrane and muscles.

These requirements could be generalized thus: The artificial mandibular section had to be compatible with and tolerated by the tissues, and be of such physical properties, mechanical construction and design as to anticipate changes to be produced by the mandibular resection.

To meet these requirements, vitallium, a procurable patented metal, of light specific

gravity, was selected. From Venable and Stuck<sup>3</sup> we learn: "Vitallium is an alloy of cobalt, chromium, and molybdenum which was

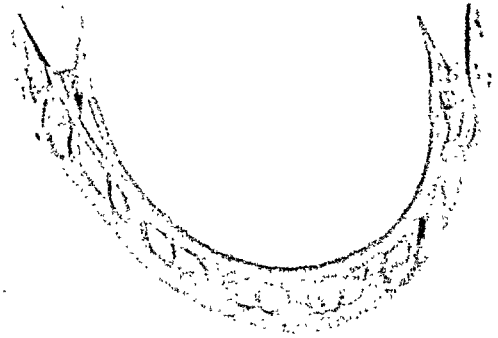


FIG. 3. Photograph of the vitallium mandibular prosthesis. Note the interspaces for joining the muscles, tie wires for sutures, and flanges with screw holes for attachment to remaining bone segments.

developed by the Austenal Laboratories of New York for dental plates. It contains no iron and is entirely resistant to body fluids. There is no corrosion of the metal itself or irritation of the tissues about it. We encountered it in our experiments on the effects of electrolysis of metals on bone in 1936, and because of its inertness, we advocated its use for bone plates and screws." This metal could be processed into the special pattern needed for our patient. Therefore, the impressions previously taken were also utilized to make a facial plaster cast with dental inserts. The maxillary and mandibular models were set into the facial cast so that each model could be removed and replaced into position when desired without destroying the composite cast.

The full length of the inferior border of the mandible from angle to angle was marked on the patient's face. A lead wire was conformed to this line. The lead wire was then transferred to the corresponding part of the facial cast. Tracings of the rami and mandible from the x-ray plates were also outlined on the facial cast. On the mandibular model, the oral extent of the swelling was noted.

With these models and markings available, a wax pattern was carved for the prosthesis. It consisted of a body to replace the removed bone, and two sets of flanges extending backwards. For all practical purposes the body



resolved itself into two heavy wires, an upper of shorter circumference, and a lower one of larger circumference, contoured from above

fasten it to the ramus with vitallium screws, while the lingual flange served to overcome the tendency of the mandibular segments to be

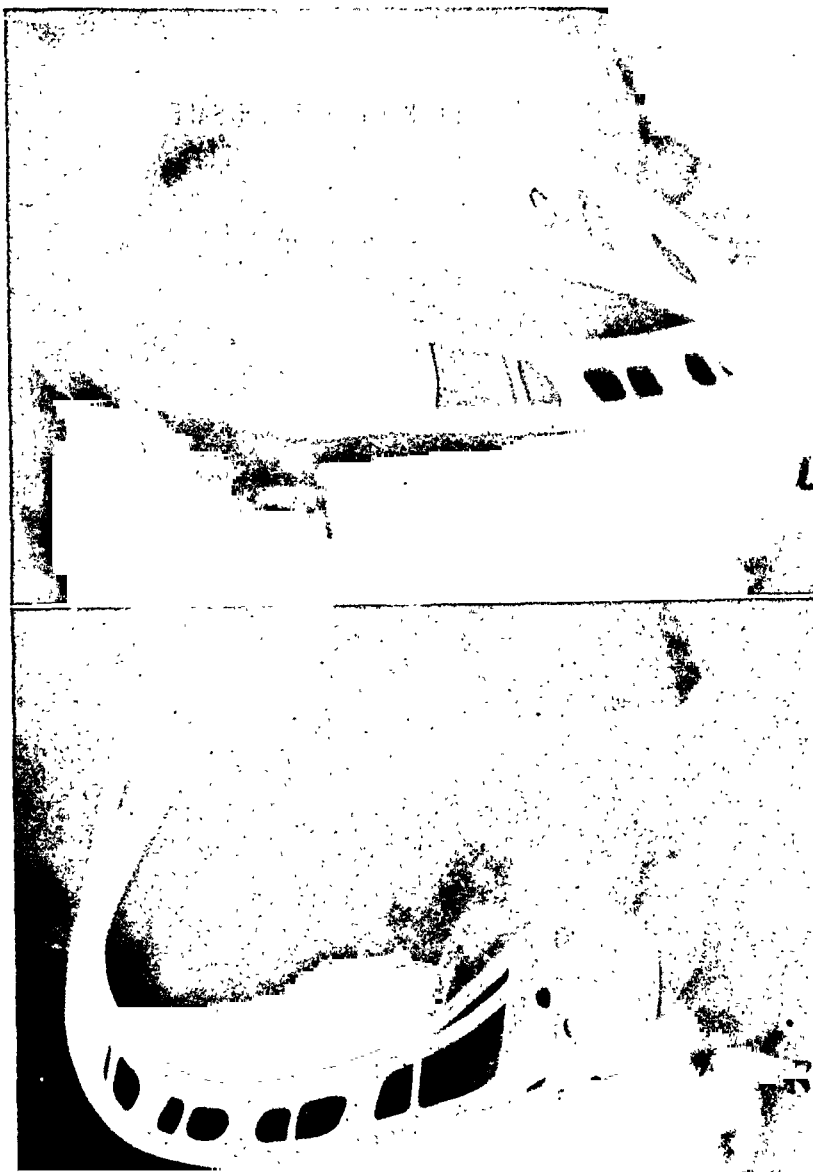


FIG. 4. A, left lateral roentgenogram showing the appliance in position and the left flanges attached to the left mandible. B, right lateral roentgenogram also showing the appliance in position with the right flanges attached to the right ramus.

downward by bridging sections and joined by smaller tie wires, thus providing ample suture attachments for muscles at the time of operation. At either end, the wires terminated in two buccal and lingual flat-ended flanges to grasp the anticipated left and right remaining bony segments of the mandible. All flanges had screw holes. The buccal flange was used to

pulled upward and inward, thus increasing the mechanical advantage by lessening the mechanical stress on the screws. The lingual flanges alone could not be used as they were surgically inaccessible for fastening purposes.

With all the provisions we could anticipate included in the wax pattern, the prosthesis was cast in vitallium metal. It was completely

processed and made ready for insertion. (Fig. 3.)

We were, therefore, ready to proceed. Before

c.) Thus the free segments were joined together and stabilized. The oral mucosa was closed. The muscles previously attached to the body



FIG. 4. C, postero-anterior roentgenogram showing the appliance in position. Note the vitallium screws through the flanges attaching the appliance to the remaining mandibular segments.

doing so, however, it had to be borne in mind that secondary hemorrhage, in some instances fatal, followed extensive mandibular resection. As a preventive, the right external carotid artery was ligated seven days prior to the resection,<sup>4</sup> and the left facial artery was ligated at the time of the resection.

Thus with the problem of hemorrhage under control, the patient was prepared, and the mandibular resection was performed. A large external incision was made along the inferior border of the mandible through the skin and muscle down to the bone extending from the left angle to the right angle. The left facial artery was tied off. All the muscles attached to the external and internal surfaces of the body of the mandible were freed from the bone revealing a large tumor mass. With a Gigli saw, the bone was cut in a safe, healthy zone distal to the diseased part. The mandibular prosthesis was then fitted into place and an attempt made to center the appliance in the median line and in the horizontal plane. Its flanges were adjusted to their respective segments and set into place. With vitallium screws, two on each side, the artificial metal mandible was secured to the remaining mandibular bone. (Figs. 4A, B and

of the mandible, i.e., the mentalis, triangularis, digastric, mylohyoid, genioglossus, and geniohyoid, were joined through the interspaces of the metallic replacement, and sutured to its tie wires from the median line along its entire length.

With interrupted sutures, the external wound from angle to angle was closed. The patient had an uneventful recovery. X-rays were taken and show the appliance in position. (Figs. 4A, B and c.) Her facial contour is fair. (Figs. 5A and B.) She can open her mouth (Fig. 5B) and talk. Her muscular function is rather favorable and is constantly improving. Of greatest importance, there was no interim of depression apparent to us; the patient seemed cheerful and appreciative.

#### SUMMARY

1. The extent of the adamantinoma and the patient's previous history provided no alternative but a drastic radical resection of the mandible.

2. The mandibular metallic prosthesis was planned, its contour and method of attachment, etc., anticipated, and its con-

struction entirely processed prior to the operation.

3. To prevent excessive bleeding and

to determine permanent benefits from the immediate insertion, attachment, and embedding of a vitallium prosthesis (artificial



FIG. 5. A, front view of patient after resection with appliance buried in the soft tissue. B, front view of patient after resection with mouth open.

secondary hemorrhage (sometimes fatal), the external carotid artery was ligated one week previous to the resection.

4. At the time of resection, and as an integral part of the operation, the metallic prosthesis or artificial jaw was joined and attached to the remaining mandibular segments uniting them into a single functioning unit. It also replaced the removed bony structure.

5. The inserted mandibular section completely prevented the usual facial collapse and other sequelae, and most important, eliminated the usual period of depression following a mandibular resection.

#### CONCLUSION

There is only a brief interval since the removal of the adamantinoma involving the whole body of the mandible in which

metal jaw). Nevertheless, the maintenance of the patient's mental health and the prevention of a caricature-like physiognomy thus far, warranted that plan of treatment. It furthermore suggests a method of approach for those hopeless individuals for whom bone grafts are unfeasible, and a manner of maintaining segments of the jaws for those who eventually might benefit from bony transplants.

#### REFERENCES

1. WINTER, LEO. *Operative Oral Surgery*. 2nd ed., p. 377. St. Louis, 1943. C. V. Mosby Co.
2. LIFTON, JACOB C. Applied orthodontics in orofacial prosthesis. *Am. J. Ortho. & Oral Surg.*, 29: 18-29, 1943.
3. VENABLE, CHARLES S. and STUCK, WALTER G. A general consideration of metals for buried appliances in surgery. *Internat. Abstr. Surg.*, 76: 297-304, 1943.
4. MCQUILLAN, ARTHUR S. *Surgery of Head and Neck*. P. 23. New York, 1941. Oxford University Press.

# THYROID CRISIS\*

## PATHOGENESIS OF HEPATIC ORIGIN

BERNARD J. FICARRA, M.D.

Fellow in Surgery, Lahey Clinic, Boston, Mass.

AND

EMIL A. NACLERIO, M.D.

Resident Thyroid Surgeon, Kings County Hospital

BROOKLYN, NEW YORK

IT is the duty of members of a house staff to undertake the major portion of the burden, in the pre- and post-operative care of patients. Early in our hospital careers our interest was enlivened by a clinical entity often associated with a tragic finale. Few syndromes are more fulminating, more formidable, or more lethal, than thyroid crisis.

In the preoperative preparation of patients with exophthalmic goiter and in the care of persons in thyroid crisis, it was realized that much of our treatment was inadvertently directed toward fortifying the liver. This fact stimulated interest in the liver and its possible relationship to hyperthyroidism and thyroid crisis.

Most of our conclusions were previously formulated by laboratory investigators. We have taken the knowledge gleaned from the laboratory and applied it to our clinical observation of the thyroid patient.

### DESCRIPTION

Zondek<sup>1</sup> was the first to describe hyperthyroid crisis and coma. He stated that this syndrome is characterized by marked motor restlessness with uncoordinated movements of the entire body, associated with a rapid rise in temperature, and a lack of reactivity on the part of the patient. Increased obnubilation may lead to a syndrome which resembles catalepsy or bulbar paralysis.

The clinical picture of storm, according to Means,<sup>2</sup> is that of a fulminating increase in the symptoms of thyrotoxicosis. The pulse may rise to 200. The patient is very irritable, often delirious, but at the same time weak to the point of collapse. Coma

may supervene and death occur. A prominent feature of storm is hyperpyrexia. In contrast to the usual preservation of heat in the presence of heightened metabolism in thyrotoxicosis, during crisis the mechanism breaks down and the temperature rapidly ascends to between 100 and 106°F. or more. It is to be looked upon, as in hyperpyrexia of sunstroke, as due to toxic destruction of the body's organization for eliminating heat. The entire course of a storm from the initial symptom to death may be only a few hours. Recovery is possible, but not the rule.

Lahey<sup>3</sup> called attention to the early signs of an impending crisis. A persistently unexplained increase in pulse rate is a definite indication of a threatening thyroid crisis. When a thyroid patient begins to show vague, transient but definite periods of irrationality an impending crisis may be in evidence. Vomiting may be another prodromal sign. This indicates the inability of the individual to take in fluids and food and thus to combat the effects of the increased combustion associated with thyroid disease. A patient with a definite diarrhea likewise becomes a candidate for a crisis because even though fluid and food be taken, they are rapidly lost as a result of the diarrhea. The metabolic balance is not maintained, hyperthyroidism becomes intensified, and the danger of a crisis is imminent.

Crile, Jr.<sup>4</sup> summarized this state: "A thyroid crisis is a vicious circle of hyperthermia and hypermetabolism. With each degree of elevation of temperature, there is an increase of 7.2 per cent in the B.M.R., and with each increase in the rate of

\* From the Thyroid Service of Dr. Anthony Pirundini, Kings County Hospital, Brooklyn, N. Y.

metabolism there is a proportionate increase in the production of heat by the body." Under these circumstances the patient burns up his tissues, until he is exhausted.

### THEORIES

As in many problems associated with the physiodynamics of disease, the exact cause of thyroid crisis is unknown. With this uncertainty, no general agreement as to etiology can be postulated. This has resulted in many theories according to the experience of investigators who have studied this entity.

Herget,<sup>5</sup> in 1940, reviewed the various theories promulgated by Europeans. Among the eccentric theories quoted was one by Just. This author stated that "the rise in temperature (in crisis) is due to the operative trauma in that disintegration of proteins takes place and leads to irritation of the heat center." Herget further reveals that many authors up to the writing of his article believed that crisis is due to postoperative hyperthyroxemia. This hyperthyroxemia may be provoked by many factors. Among these provocative causes he mentions: (1) Operative manipulation of the thyroid gland which mechanically increases thyroxine in the blood, and (2) reflex influence on the hormonal secretion by injury to adjacent nerves.

Bier (quoted by Herget) assumed that hyperthyroid coma actually constitutes a hypothyroxemic shock due to lack of active thyroid hormone. Sauerbrück (quoted by Herget) attributes crisis to a sudden reduction in the hormone concentration after subtotal resection. This leads to a disturbance of endocrine and nervous equilibrium producing postoperative crisis. Kappis (quoted by Herget) stressed a shift in the ionic equilibrium toward the acid side as a participating factor in the causation of crisis.

The thymus has been accused as the etiological agent in crisis by Kocher (quoted by Herget). He observed thymic hyperplasia in more than 50 per cent of

deaths from Basedow's disease. Garré and Borchard elaborated upon this thought by stating that anoxia is produced in patients with a persistent thymus. This acts on the heart and produces an increase in the effect of thyroid secretions. Garré (quoted by Herget) was able to cure patients with Basedow's disease by extirpation of the thymus. Foss and associates<sup>6</sup> studied this problem and concluded that: "while so-called thymic death does not resemble in many respects death from thyroid crisis, the majority of patients dying in crisis will be found, at autopsy, to have a persistent and hypertrophied thymus."

Herget<sup>5</sup> likened crisis to an allergic or anaphylactic reaction. He believed that crisis might be prevented in the same way as the anaphylactic shock of serotherapy and can be avoided by preliminary injection of a small desensitizing quantity of serum.

McGregor<sup>7</sup> thought that an underlying polyglandular stimulation in certain adolescents resistant to iodine was a factor. Thus he stressed preoperative radiation of the pituitary and adrenal glands with satisfactory results. In keeping with this endocrine concept, Nash<sup>8</sup> called attention to the antuitary. He maintains that thyroidectomy causes the antuitary to produce an increase of thyrotrophic hormone plus other hormones. This postoperative outpouring of potent antuitary substances may induce the so-called thyroid crisis, "one or more of the hormones having probably a greater influence in this direction than the others."

Further thoughts on the relation of the thyroid gland to other glands attracted interest to the adrenals. Levy<sup>9</sup> was the first investigator to demonstrate that injections of adrenalin cause an action current in the thyroid gland. In addition he pointed out that thyroid secretion renders more excitable the sympathetic nerve endings which are acted upon by adrenalin. It has been further revealed that glycosuria in animals as a result of the administration of adrenalin disappears after excision of

the thyroid, the glycosuria reappearing, however, when the animal is fed thyroid extract. There is known to be a reciprocal inhibition between the thyroid and the pancreas on the one hand and between the pancreas and chromaffin system on the other.<sup>10</sup>

The adrenalin test of Goetsch<sup>11</sup> is based on the work of Levy who showed that the sympathetic nerve endings in hyperthyroid disease were abnormally sensitive to small doses of adrenalin. Further evidence to support the adrenal-thyroid relationship was found by Goetsch and Ritzmann.<sup>12</sup> Hyperadrenalism whether due to psychic influences, anoxemia or other causes, may exert some influence in the precipitation of thyroid crisis. Prevention, therefore, of both disturbing stimuli and anoxemia is essential to the well-being of the thyrotoxic patient. The evidence offered by Goetsch and Ritzmann indicates that adrenalin should not be given in thyrotoxicosis.<sup>13</sup> Additional studies by Maddock and his associates<sup>14</sup> increase the evidence in favor of the adrenal theory. Substantiating the relationship between the adrenals and thyroid crisis, Rea<sup>15</sup> has employed spinal anesthesia in the treatment of thyroid crisis. This procedure is offered on the basis that spinal anesthesia temporarily denervates the adrenal glands. The observations by Brace and Reid<sup>16</sup> bring forth additional clinical evidence regarding the ergototoxine-ergotamine-adrenalin relationship.

In 1936, Lahey<sup>17</sup> reiterated the hypothesis that hyperthyroidism was allied to hyperiodinism. The work of the Lahey Clinic chemist, Perkin, on blood iodine and its relation to toxic thyroid states is widely known. He found that in normal individuals thyroxine is confined to the thyroid gland; in toxic states increased thyroxine is found circulating in the blood. The low amount of iodine in the thyroid tissue represents a state in which the thyroxine produced in an excessive amount is rapidly discharged from the thyroid. Thus when patients are improved or relieved of their

hyperthyroidism, there is an immediate increase in the amount of iodine stored within the thyroid gland. These facts fit most satisfactorily into the theory of hyperiodinism representing hyperthyroidism.

Other concepts of thyroid crisis have been offered for consideration. Ewald<sup>18</sup> ascribes postoperative crisis to a sudden "flooding of the organism" with thyroid secretion, but he suggests that perhaps it is really due to sudden deprivation of thyroid secretion instead. The theory of Letchford<sup>19</sup> stating that crisis is due to thyroid failure appears to have little basis in fact. Pedersen studied the work of Schneider<sup>20</sup> on the serum sodium content and it was not corroborated. It was apparent to Pedersen<sup>21</sup> that determinations of the serum sodium have no value in relation to hyperthyroidism. Maddock and his associates<sup>22</sup> thought crisis might be explained on ionic disturbance. However, their experiments led them to conclude that searches for abnormalities in inorganic ion concentrations in blood have not been revealing.<sup>22</sup>

All the theories advanced as to the etiology of thyroid crisis have not satisfactorily answered the numerous questions associated with this phenomenal syndrome. In the quest for the answer to some of these questions many investigators have been attracted to the rôle of the liver in thyroid disease.

#### THE HEPATOTHYROID RELATIONSHIP

The correlation between the largest gland in the human body, the liver, and the potent cervical endocrine gland, the thyroid, was not suspected until 1905. Since that year pathologists and laboratory investigators called attention to pathological changes in the liver associated with hyperthyroidism. Both experimental and histological evidence was offered to associate the liver with thyroid dysfunction. In spite of all the evidence presented, clinicians and surgeons ignored the proffered benefits derived from the laboratory

and theorized as to the etiology of thyroid crisis.

The stream of experimental pathological studies began in 1905. In that year Schryver<sup>23</sup> observed a greater degree of autolysis in the livers of thyroid-fed than of control animals at the end of twenty-four hours. Farrant<sup>24</sup> (1913) found that thyroid-fed cats and rabbits in which a modified picture of exophthalmic goiter had been produced, exhibited at post-mortem examination, in addition to other changes, fatty degeneration of the liver, most marked around the center of the lobules. In the same year, Cramer and Krause<sup>25</sup> noted that excessive thyroid administration resulted in glycogen depletion of the liver. Kuriyama<sup>26,27</sup> studied the effect of thyroid feeding on white rats and found that within three to five days practically all of the animals exhibited a decreased glycogen content of the liver. Hashimoto and Goodpasture (1921)<sup>28,29,30</sup> fed albino rats and rabbits thyroid substance in an endeavor to produce histological changes in the myocardium. To their surprise both workers produced parenchymatous changes in the liver. Goodpasture reported a clinical case of hyperthyroidism which exhibited at autopsy progressive atrophic cirrhosis of the liver with numerous vacuolated nuclei suggesting glycogen depletion. Haban (1935)<sup>31</sup> was able, by thyroid feeding, to produce necrotic changes in the livers of cats and rabbits. In addition he observed a total depletion of glycogen content. These findings were confirmed experimentally by Zeldenrust and Van Beek.<sup>32</sup>

Additional scattered reports have been recorded in the literature to establish a definite thyrohepatic relationship. Cameron and Karunaratne<sup>33</sup> published an extensive study on this relationship based on thirty cases. These investigators attached no special significance to their studies. They considered the pathological finding of necrosis as evidence of a severe toxemia based on atrophy and cirrhosis. Roessle<sup>34</sup> postulated an hypothesis that in

the presence of thyrotoxicosis a toxin is elaborated which acts on the liver because of the detoxifying function of that organ. Parturier and Delerue<sup>35</sup> stated that 30 per cent of all patients with hepatic disease present signs and symptoms attributable to the thyroid gland. They believed that, from clinical observation, the effect of the thyroid on the liver is less marked than the effect of the liver on the thyroid: "Thyroid function is unlatched only when hepatic function fails."<sup>35</sup> Rome<sup>36</sup> called attention to the frequency with which thyroid failure is complicated by various types of hepatic dysfunction. An analysis of 107 autopsies for toxic thyroid disease was made by Beaver and Pemberton at the Mayo Clinic.<sup>37</sup> From their survey they believed that in most instances the lesions in the liver appeared to be an integral part of the syndrome of exophthalmic goiter and to be due directly to thyroid intoxication.

More specific elucidation of the pathological changes in the liver due to thyroid disease was forthcoming. Weller<sup>38</sup> described the usual liver lesion as an interlobular fibrosis with lymphocytic infiltration. Among the reports published on the study of liver damage in patients who died of thyroid crisis is that of Youmans and Warfield.<sup>39</sup> They reported liver damage in four and jaundice in three of five patients who died in crisis. Assmann<sup>40</sup> distinguished a type of hyperthyroidism associated with a rapidly lethal outcome. In these cases the more severe conditions passed into acute atrophy of the liver. Mahorner<sup>41</sup> reported an interesting case of exophthalmic goiter in which jaundice was a prominent finding. The fact that it disappeared within a month after thyroidectomy suggested to him that liver damage can be caused by thyrotoxicosis, and that adequate therapy can restore the liver to normalcy. Foss and associates<sup>6</sup> in a study of eleven cases of thyroid deaths found but one normal liver in the cases of true crisis.

The above resumé of the literature associated with hepatic disorders in thyrotoxicosis, strongly indicates a definite relationship between these two organs. Hence it can be appreciated that both the experimental and pathological evidences previously enumerated indicate a direct relationship between toxic thyroid disease and liver damage. Whichever one is accepted as the causative factor is not of primary concern. Investigators appear more interested in discovering some method by which the state of the thyroid patient can be estimated in terms of the hepatic factor. For this reason attention has been given to formulating laboratory tests on liver function in the thyroid patient.

#### LABORATORY TESTS ON LIVER IN THYROID DISEASE

Possessing a tremendous reserve capacity, the liver has the ability to function in the presence of extensive parenchymatous damage. For this reason an efficient test of hepatic efficiency must of necessity be most sensitive. In the pursuit of the ideal test many procedures have been offered.

In view of the fact that the maintenance of a normal blood sugar is a most important function of the liver, it is preserved to the very end.<sup>42</sup> Of the tests on carbohydrate function the galactose tolerance test has been most favored.<sup>42</sup> Judd<sup>45</sup> considered that methods for detecting hepatic injury in relation to sugar metabolism were so unreliable as to suggest that they affected only the reserve capacity of that organ.

Urea is formed in the liver, and uric acid is presumably formed and destroyed in that organ. Thus it might be expected that blood urea and uric acid determinations would be a secure calibration of early hepatic dysfunction. However, such determinations are of little value until liver damage is far advanced.<sup>42</sup>

Other studies on hepatic function involved tests for cholesterol. The normal values for blood cholesterol are usually 200 mg. of cholesterol and 100 mg. of

cholesterol esters per cent. Formerly, variations of from 30 to 50 per cent in the ratio were considered normal; but now it is believed that the free cholesterol in normal individuals is usually not greater than 30 per cent of the total.<sup>42</sup> Changes in the ratio are more important than changes in the concentration of total cholesterol, since the esterification of cholesterol esters from cholesterol and high fatty acids is accomplished in the liver. Pickhardt<sup>44</sup> and his associates found the cholesterol of the blood serum to be a very valuable index of hepatic reserve, as did Sperry,<sup>45</sup> whereas other observers have stressed the ester cholesterol.<sup>42</sup>

More specific liver function tests were studied in attempting to evaluate the hepatic status in hyperthyroidism. Serum protein values of thyroid patients have been studied by several investigators. Bartels found the total serum proteins below normal in 63 per cent of the patients he studied.<sup>46</sup> This protein depletion was noted when the patients were first seen and in 37 per cent of the cases after ten days of therapy.<sup>46</sup> Bartels observed a definite relationship between the level of total serum protein and the severity of the hyperthyroidism as indicated by the necessity for surgery in stages. Further studies on the inorganic sodium content of blood serum in hyperthyroidism were made by Pedersen.<sup>20</sup>

The importance of iodine and its relationship to hyperthyroid states has been mentioned previously. With this association in mind most interesting studies have been evolved about the blood iodine test. Data have been accumulated which point to the liver as a factor in iodine metabolism.<sup>47</sup> Experimental evidence has been offered to indicate that the liver is involved in normal iodine metabolism. Maruno<sup>48</sup> has stated that iodine is excreted with bile. Yuzuriha<sup>49</sup> maintains that the reticulo-endothelial system is concerned with the removal of iodine from the blood.

With these studies as a background De Courcy<sup>50</sup> attempted to correlate elevated



blood iodine to disturbed liver function. This investigator pointed to the liver as a potent factor in the regulation of blood iodine and speculated, in the absence of proof, that the activity of the reticulo-endothelial system might play an important part. He has tentatively assumed that when the iodine content of the blood is below 100 micrograms per 100 cc, operation can be done with reasonable safety as far as the liver status is concerned.<sup>50</sup>

Of all the tests employed in studying hepatic function in thyroid disease, the most satisfactory procedure is the Quick hippuric acid test of detoxifying function. This method has been employed extensively and successfully at the Lahey Clinic and by Boyce.<sup>42</sup> Boyce used this test in 130 cases of thyroid disease.<sup>51</sup> He concluded that hepatic dysfunction in hyperthyroid disease is more frequent and more serious than was generally realized. He postulated that the progression or regression in function, as exhibited by serial Quick tests, corresponds to clinical improvement or lack of improvement. The degree of hepatic dysfunction is usually related to the clinical severity of the disease, and to the degree of toxicity as exhibited by the basal metabolic rate.<sup>51</sup> Improvement in liver function occurs in patients who respond clinically to preparation for operation. This he believes to be a useful test in evaluating the results of therapy. In the employment of the Quick test it is important to know that its greatest value is derived when it is used serially. When it is used in this way, it is possible to state that a patient is a good or bad risk from the hepatic standpoint. It is also possible to determine, from the response to treatment as expressed by this test, whether the risk has improved, remained stationary, or has become worse.<sup>42</sup>

From all the evidence thus far presented, it is evident that many isolated studies have pointed to the importance of liver function in toxic thyroid disease. The various tests employed indicate that hyper-

thyroidism has a damaging effect on the liver.

#### CLINICOPATHOLOGICAL EVIDENCE FOR THE HEPATOTHYROID CONCEPT

In the presence of the universal and frequent experimental results, clinicians were late to grasp the full significance of the laboratory evidence in support of the hepatothyroid association. The liver and thyroid have a common anatomic relationship in that both are glands. Experimental physiopathologists, and later clinicians, have discovered a closer interrelationship between these organs than would appear from this casual anatomic fellowship.

It is only within the last decade that the literature has contained clinical references to the hepatothyroid correlation. Surgeons now recognize that the liver in thyroid disease is of significant importance. Many of them have believed that deaths occurring in hyperthyroidism are chiefly liver deaths. Boyce<sup>42</sup> likens thyroid crisis to "liver shock" type of death which sometimes follows surgery of the biliary tract. Connell<sup>52</sup> believed that the syndrome of rapid hyperpyrexia death occurred only after biliary tract surgery. However, he soon abandoned this view and believed it could occur in many other operations.

Hyperpyrexia death may follow operations in badly prepared patients. It has been allied to thyroid crisis because the clinical picture closely simulates the syndrome seen in untreated or mistreated toxic thyroid disease. As to the cause of this calamity of thyroid crisis, Boyce suggests that the toxic overstimulated metabolism results in combustion of the protective glycogen of the liver beyond the degree of safety.<sup>42</sup> When this point is reached there develops sudden and extreme hyperpyrexia, an almost uncountable pulse, vomiting, and diarrhea. Restlessness may supervene which may pass into delirium, coma and death.

Other authorities have concurred in the thyrohepatic relationship. Both Criles<sup>43</sup> and later Dinsmore<sup>54,55</sup> have remarked that

liver failure is the most common cause of thyroid delirium, mental confusion and death in thyroid crisis.

The younger Crile expressed this concept as a problem of hepatic failure and metabolic exhaustion.<sup>4</sup> He emphasizes the possibility of jaundice. Visible jaundice may be present in some cases, whereas, in others repeated determinations of icteric indices may fail to show any increase above normal levels. If the icterus index is not elevated, there is no way of relating the syndrome to the liver and hence it is called "metabolic exhaustion." If the presence of jaundice is noted, it is classified as "hepatic failure."<sup>1</sup>

Lahey<sup>56</sup> has stated that he is more and more certain that deaths due to hyperthyroidism are chiefly liver deaths. He has adduced in support of this thought not only the clinical picture of crisis, but the efficacious utilization of intravenous glucose to combat the excessive combustion resulting from hyperthyroid states. He believes that with excessive hyperthyroidism goes excessive combustion and "when fluid and fuel intake is inadequate to meet this excessive degree of combustion, progressive autocombustion occurs with exhaustion of available glycogen and diminution of the glycogen reserve in the liver."<sup>3</sup>

Additional studies have been made in substantiation of the close relationship between the liver and hyperthyroidism. An intimate association between thyroid crisis and functional changes in the liver was suggested by Lord and Andrus<sup>57</sup> on the basis of their study of the plasma prothrombin level in thirty-six patients with hyperthyroidism. Frazier and other surgeons<sup>58-61</sup> at the University of Pennsylvania published important results on the therapy of thyroid disease as directed to the liver factor. Studies by Bartlett<sup>62,63</sup> confirm and emphasize the importance of liver damage in toxic thyroid disease.

Early studies on the pathological picture of the liver in thyroid disease originated in the experimental laboratory. With the

influence of adrenalin in thyroid disease as a guide, Perrazzo, in 1934,<sup>64</sup> was able to produce advanced fatty degenerative changes in the liver. At that time this finding was considered to be the major pathological lesion observed in many fatal cases of hyperthyroidism. Perrazzo accomplished this experiment by the intravenous injection of moderate doses of adrenalin.<sup>64</sup>

Shaffer in a study of the livers from twenty-four fatal cases of toxic thyroid disease, found a loss of liver weight, fatty infiltration, cirrhosis, and lymphocytic infiltration in the periportal region often associated with patchy fibrosis.<sup>65</sup> Webster and Chesney<sup>66</sup> have shown that when rabbits are fed a diet rich in cabbage a marked degree of goiter results. Examination of these thyroid glands showed a considerable degree of hyperplasia which was considered to be compensatory. According to Marine<sup>67</sup> the active principle in the cabbage is a cyanide. Thyroid hyperplasia and even exophthalmos may be produced in young rabbits by the injection of cyanides, which greatly lower the oxidation in body tissues. Cyanide is toxic to the liver and herein may be the cause for the hepatic picture produced by these investigators which was analogous to the findings of Shaffer.

Boyd has summarized the major pathological hepatic picture in thyroid disease: "There is no constant pattern in the liver lesions, but they are essentially congestion and degeneration. Fatty degeneration is extremely frequent. There may be acute necrosis, both focal and central. Subacute toxic atrophy may occur, with the development of cirrhosis and nodule formation."

#### ANOXIA AND HEPATIC DISEASE

The increased metabolism of the thyroid patient has been indicted for the facility with which these individuals develop anoxia. Recent literature has witnessed several excellent monographs demonstrating the pathological changes wrought in the liver subsequent to anoxia. Under such conditions of hepatic anoxia, the damaged

liver appears to accelerate the thyroid gland to hyperactivity. In a situation of this type a mutual distortion of hepatic and thyroid function results. Anoxic damage consumes the hepatic protein elements plus the stored glycogen. These debilitating factors leave a cadaveric organ which is depleted of all its reserve capacity. In this state an additional glycogenolytic process as demanded by thyroid hypermetabolism cannot be satisfied. This is the basis for liver exhaustion and thyroid death.

Experimental evidence on the extraordinary sensitivity of thyroid-fed rats to want of oxygen was recorded by Asher and Duran in 1920.<sup>69</sup> They showed that hyperthyroid animals could not tolerate even minor degrees of anoxia. Two years previously Streuli and Asher<sup>70</sup> found the converse to be true that thyroidectomized rats were able to tolerate a lack of oxygen which brought normal animals to the point of death by asphyxiation.

It has only been recent studies which have revealed the effects of anoxia on the liver in hyperthyroidism. Hepatic distress subsequent to oxygen want is logical. The reason for this is that the liver cells are closer to asphyxiation than other cells of the body because only 25 per cent of their blood supply is arterial.<sup>71</sup> Reinwein and Singer<sup>72</sup> led one to assume that increased oxygen demand by the liver in a hyperthyroid state leaves a narrow vital margin of safety which is easily destroyed. In the same trend of thought McIver<sup>73</sup> has shown that the liver is particularly susceptible to injury under conditions of hyperthyroidism.

More recent experiments by McIver and Winter<sup>74</sup> elucidate the effect of anoxia on the liver during artificial hyperthyroidism in rats. These investigators studied the behavior reaction of the hyperthyroid and of the normal animals when exposed to low atmospheres of oxygen (11 per cent). The normal animals showed no signs of acute distress excepting a slight increase in respiratory rate. The hyperthyroid animals were restless and apathetic. They studied

twenty-six rats of which seventeen had received injections of crystalline thyroxine. Nine of the seventeen hyperthyroid rats died after varying periods of anoxia. The first two hours in the low oxygen atmosphere seemed to be the most critical for the hyperthyroid rats.

The effects produced by oxygen lack is one of glycogen imbalance. The studies of McIver confirm some aspects of the work produced by Lewis and his associates.<sup>75</sup> In their studies on the rôle of the adrenal cortex in acute anoxia they confirmed the previous conclusions of Evans.<sup>76,77</sup> All showed that hepatic glycogen tends to fluctuate in rats exposed to low atmospheric pressure.

Knowing *de facto* that a deleterious damage occurs in the liver due to the factors presented, pathological studies have confirmed definite anatomic alterations in the liver. Scholars concerned themselves with this problem as early as 1913. Farrant<sup>78</sup> produced histological changes in the liver by administering thyroxin. Similar results were produced by Gerlei<sup>79</sup> who employed large and even fatal doses of thyroxin. McIver attempted in his experiments to use non-lethal doses, the amount employed was merely sufficient to produce a hyperthyroid state. In this way he hoped to avoid pathological changes in the liver due to overdosage. His plan was to produce alterations in hepatic tissue due to anoxia in hyperthyroid animals. His subjects were all healthy and free from disease. This healthful state of the animals was important because Haban<sup>80</sup> in studying the effects of crystalline thyroxin injections on the liver found tissue change only when some intercurrent infection was present.

The most lucid study on the histological pathology of the liver was made by McIver in his experiments.<sup>75</sup> He has shown that the pathological material from the rats killed after receiving crystalline thyroxin in non-lethal doses failed to reveal any notable histological abnormalities of the liver. However, when the cells were compared

with those of the livers of normal well fed rats, the cells in the livers of thyroxin treated rats were more homogeneous and compact. The appearance of the cells, however, did not differ essentially from the hepatic cells of a starved animal. McIver attributed this analogy to the fact that hepatic glycogen was diminished markedly.

Anoxic changes have been recorded in hyperthyroid rats. As might be expected, the lesions in animals that died or were killed after short exposures to oxygen deficit were not advanced. These changes consisted of fatty changes, vacuolization of the cells and engorgement of the blood vessels. In the animals exposed for longer periods the degenerative changes were severe and widespread.<sup>75</sup> A summation of the pathological findings may be stated as: (1) Necrosis most pronounced around central veins; marked engorgement of the sinusoids especially in the vicinity of the central veins; (2) The cell outlines were often lost. The cells in the areas of degeneration showed an affinity for eosin. Associated with the loss of cell boundaries were found pyknotic nuclei.

From the pathological data already presented the noxious effects of anoxia upon the liver is obvious. It is further evident that in the patient with hyperthyroidism every precaution is essential in order to avoid the complications associated with a low oxygen tension. This problem gives rise to the choice of anesthesia in a toxic thyroid patient who is a potential candidate for anoxic anoxia. For this reason Colcock<sup>81</sup> has stressed this point. Nitrous oxide was abandoned because too little oxygen (usually 10 per cent) was available to the thyroid patient whose oxygen demand was two to three times that of the average patient. Avertin enjoyed popularity and was frequently employed with nitrous oxide. Avertin, a respiratory depressant, has in the experience of Cole and Brunner<sup>82</sup> occasionally increased the toxicity in patients with severe hyperthyroidism. These problems on anesthesia

brought to light the rationale and use of oxygen in the postoperative treatment of hyperthyroidism as well as the value of oxygen during thyroidectomy.<sup>83,84</sup>

#### COMMENTS AND CONCLUSIONS

From the literary review it can be stated that many surgeons and investigators have studied the rôle of the liver in thyroid disease. Of all these, several have intimated and few have definitely incriminated the liver as the seat of distress in thyroid crisis. Our review of this subject leads us to believe that the liver in some way is the organ to be indicted as a potent factor in the pathogenesis of thyroid crisis.

Among the reasons for this belief are: (1) The clinical picture of crisis closely simulates exhaustion resulting from hepatic hyperpyrexia. (2) Experimental evidence and the morbid anatomical findings indicate the close association between hyperthyroidism and the liver. (3) Boyce's results with the Quick hippuric acid test of liver function has been offered as proof of liver damage occurring as the result of thyroid disease. (4) The physiological imbalance and pathological changes in the liver due to anoxemia has been established. Anoxia in hyperthyroidism is common knowledge. (5) The interrelationship between hyperadrenalism, hepatic glycogenolysis and the experimental production of toxic thyroid signs by injections of adrenalin has been emphasized.

The premise of our discussion, therefore, is that the most important organ, exclusive of the thyroid itself, concerned in the production of thyroid crisis is the liver. Physiological failure of this organ will cause so-called thyroid death. This conclusion is reached following clinical observation, experimental data, laboratory function tests and objective findings as revealed by pathological anatomy.

The causative or exciting agents in the production of hepatic imbalance may be multiple or a combination of several. Of all the phases discussed on this aspect of our subject the most plausible possibili-

ties are hyperadrenalism and hepatic anoxia. These states either alone or acting synergistically in the presence of hyperthyroidism may be the fundamental destructive influences in the causation of crisis. Hyperadrenalism may be the activator in depleting the liver of its available glycogen. In this state of insufficiency, the hepatic anoxia resulting from increased hypermetabolism produces the lethal blow which precipitates crisis and the eventual hyperpyrexia thyroid death.

Attention is called especially to anoxia. It is strongly believed that the acute pathological lesions found in the livers of patients dying of hyperthyroidism are the result of anoxia. This is a problem of clinical importance, since the occurrence of anoxia in hyperthyroidism is commonly known. Especially is this of great concern in the production of postoperative crisis, when tracheal obstruction, pulmonary edema or other complications may interfere with adequate pulmonary aeration.

We are not unmindful of the fact that the liver may be merely a solitary reflection of a generalized somatic picture. Anoxemia may affect all the organs in the body in the production of crisis. The liver, however, has been stressed in hyperthyroidism because its normal physiology and pathological physiology can be tested with ease and because this organ is subjected to routine examination at autopsy. That physiological discord in crisis is revealed in other organs and tissues of the body is appreciated. Even though this is known, we believe that the fulminating picture of crisis and death occurs only when the liver has been burdened beyond its ability to compensate for the demands required under the stress and strain of thyrotoxicosis.

On the basis of all the proof offered as to the rôle of the liver in hyperthyroidism, a notation on preoperative preparation is not amiss. Fortification of the liver should be of primary concern. This should include a liberal carbohydrate diet, glu-

cose by mouth, or by vein, and preferably supplemented by decholin, a definite proportion of protein in the diet, oxygen therapy, vitamins and plasma transfusions. In this regard Lahey<sup>17</sup> has stated: "There is one point regarding the treatment of thyroid crises and that is the need to give these patients fluid and glucose constantly and not intermittently. There is a tendency to be intermittent. This is unwise since it leaves periods during which the excessively activated metabolism will still consume the liver reserve. It is necessary in patients with thyroid crises to give them fluids and glucose quite constantly throughout the entire day if one wishes to extricate them from these serious thyroid states."

The topic of preoperative preparation brings to mind the diversity of opinion as to multiple-stage operations in thyrotoxic patients. In those patients with toxic goiter, known to be recalcitrant to iodine therapy and considered unfavorable operative risks; surgeons in order to prevent postoperative crisis, have resorted to multiple-stage operations. It is our belief that the beneficial effects of this procedure have not been due to the simplicity of the operation. Credit must be given to the fact that the respite between stages has given the patient a preoperative regimen on more than one occasion. This preparation directed toward "building up the patient" has inadvertently fortified the liver against a future thyroid crisis. In keeping with this thought it is believed that a multiple stage procedure is not the answer to the prevention of crisis, but rather that rehabilitation of the liver is the *sine qua non* of prophylaxis.

One of the purposes of this communication is to bring to the attention of the thyroid surgeon that prophylaxis against thyroid crisis is much preferable to therapy after the syndrome has developed. With this idea before us we have accentuated the value of preoperative rehabilitation of a liver suspected of dysfunction and of fortifying an apparently normal liver. In the preoperative care of patients

suspected of being a candidate for thyroid crisis, we have pursued the following régime: (1) complete bedrest, (2) lugalization, (3) sedation (phenobarbital, bromides); (4) thiouracil is administered until BMR is normal (0.6 Gm. daily); (5) oxygen tent to combat anoxia and hyperthermia (three days). By placing a patient in a tent an evaluation of the psyche can be estimated. If the patient is perturbed by the tent he is not psychologically prepared for operation. (6) Glucose intravenously plus amino acids and vitamin B<sub>1</sub> (for three days), (7) blood transfusions, (8) cardiac therapy when indicated. It is to be remembered that digitalization in the presence of hyperthyroidism necessitates larger doses of digitalis. The dosage usually increases with the hypermetabolic state. (9) The patient's psyche is strongly considered. The hyperthyroid individual is treated as a psychosomatic entity.

By judiciously adhering to the above regimen we have avoided crisis on the thyroid service at Kings County Hospital during the past two years. The best guides to the patient's response to therapy and calibration as to operability are: (1) The patient's mental attitude, (2) the fall and maintenance of a normal or near normal pulse rate, and (3) a consistent fall and maintenance of a lowered basal metabolic rate. We believe that by stressing the rôle of the liver in crisis, future clinical and laboratory investigators may find the solution to this intricate problem.

In conclusion may we reiterate that clinical observation has suggested a possible hepatic basis for the pathogenesis of thyroid crisis. The physiologist and experimental clinician have presented evidence substantiating this belief. Both gross and microscopic hepatic studies have augmented the proffered evidence. The liver, therefore, when distressed due to glycogen depletion, may be accused as the death producing factor in accelerated hyperthyroidism. By promulgating this concept, it is hoped that interest will be stimulated toward that organ. From this stimulus

some future investigator may confirm or deny the master rôle of the liver as the major etiological agent in the production of thyroid crisis.

#### REFERENCES

1. ZONDER. Quoted by Herget.
2. MEANS, T. H. *The Thyroid and Its Diseases*. Philadelphia, 1937. J. P. Lippincott Co.
3. LAHEY, F. H. Acute hyperthyroidism (thyroid crises). *New York State J. Med.*, 33: 857, 1933.
4. CRILE, GEORGE, JR. Important factors in the surgical management of patients with severe hyperthyroidism. *South. Surg.*, 11: 282, 1942.
5. HERGET, R. Origin and prevention of hyperthyroid coma. *Chirurg.*, 12: 417, 1940.
6. FOSS, H. L., HUNT, H. F. and McMILLAN, R. The pathogenesis of crisis and death in hyperthyroidism. *J. A. M. A.*, 113: 1090, 1939.
7. MCGREGOR, J. K. Hyperthyroid crisis. *West. J. Surg., Obst., & Gynec.*, 49: 367, 1941.
8. NASH, JOSEPH. *Surgical Physiology*. Baltimore, 1942. C. Thomas.
9. LEVY, R. L. Studies on the conditions of activity in endocrine glands, iv. The effect of thyroid secretion on action of adrenin. *Am. J. Physiol.*, 41: 492-511, 1916.
10. RIENHOFF, W. F. *Diseases of Thyroid Gland*. Chap. 1, vol. VI. In Lewis & Walters Practice of Surgery. Hagerstown, Md., W. F. Prior Co.
11. GOETSCH, E. Studies on disorders of the thyroid gland; hypersensitiveness test with especial reference to "diffuse adenomatosis" of the thyroid gland. *Endocrinol.*, 4: 389-402, 1920.
12. GOETSCH, E. and RITZMANN, A. J., JR. Thyroid disorders vi. The suprarenal factor in reactions to thyroidectomy. *Arch. Surg.*, 29: 492-510, 1934.
13. MEANS, J. H. Diagnosis and treatment of hyperthyroidism. *Canad. M. A. J.*, 43: 509-513, 1940.
14. MADDOCK, W. G., COLLIER, F. A. and PEDERSEN, S. Thyroid crisis: its relation to liver function and adrenalin. *Tr. Am. Ass. Study of Goiter*, p. 61, 1936.
15. REA, CHARLES E. The treatment of thyroid crisis. *Minnesota Med.*, 25: 368, 1942.
16. BRACE, D. E. and REID, C. L. The use of ergotoxine and ergotamine in the surgical management of thyrotoxicosis. *Ann. Surg.*, 113: 62, 1941.
17. LAHEY, F. H. Critical thyroid states, diagnosis and treatment. *Surg. Clin. North America*, 16: 1521-1531, 1936.
18. EWALD, W. Results of treatment in exophthalmic goiter. *Deutsche Ztschr. f. Chir.*, 239: 275, 1933.
19. LATCHFORD, J. K. The significance of the post-operative thyroid reaction. *Canad. M. A. J.*, 32: 165, 1935.
20. SCHNEIDER, E. Concerning the broadening of the indications for operation in exophthalmic goiter through the recognition at the bedside of a secondary thyrogenic injury to the liver. *Internat. Clin.*, 2: 87-98, 1934.
21. PEDERSEN, S., MADDOCK, W. G. and COLLIER, F. A. Serum sodium in relation to liver damage and

- hyperthyroidism. *Proc. Soc. Exper. Biol. & Med.*, 36: 491-94, 1937.
22. MADDOCK, W. G., PEDERSEN, S. and COLLIER, F. A. Studies of blood chemistry in thyroid crisis. *J. A. M. A.*, 109: 2130-2135, 1937.
  23. SCHRYVER. Quoted by Weller. Hepatic lesions associated with exophthalmic goiter. *Tr. Ass. Am. Physicians*, 45: 71-75, 1930.
  24. FARRANT, R. Hyperthyroidism: its experimental reproduction in animals. *Brit. M. J.*, 2: 1363-1367, 1913.
  25. CRAMER and KRAUSE. Cited by Weller, 1930.
  26. KURIYAMA, S. Influence of thyroid feeding upon carbohydrate metabolism. *Am. J. Physiol.*, 43: 481-496, 1917.
  27. KURIYAMA, S. Influence of thyroid feeding upon carbohydrate metabolism. I. Storage and mobilization of liver glycogen in thyroid fed animals. *J. Biol. Chem.*, 33: 193-205, 1918.
  28. HASHIMOTO, H. The heart in experimental hyperthyroidism with special reference to its histology. *Endocrinol.*, 5: 579-606, 1921.
  29. GOODPASTURE, E. W. The influence of thyroid products on the production of myocardial necrosis. *J. Exper. Med.*, 34: 407, 1921.
  30. GOODPASTURE, E. W. Myocardial necrosis in hyperthyroidism. *J. A. M. A.*, 76: 1545-1551, 1921.
  31. HABAN, G. I. *Über die Veränderungen bei experimentellem F. . . . z. path. Anat. u. z. allg. Path.*, 95: 573-589, 1935.
  32. ZELDENRUST, J. and VAN BEEK, C. C. Morphologic and experimental contribution to the pathogenesis of hepatic changes in exophthalmic goiter. *Neder. tijdschr. v. geneesk.*, 83: 889, 1939.
  33. CAMERON, G. R. and KARUNARATNE, W. A. Liver changes in exophthalmic goiter. *J. Path. & Bact.*, 41: 267-282, 1935.
  34. ROESSLE, R. Über der veränderung der Leber bei der basedowischen Krankheit und ihre bedeutung für die entstehung anderer organsklerosen. *Virch. Archiv.*, 291: 1, 1933.
  35. PARTURIER, G. and DELERUE, J. Les syndromes hépato-thyroidiens. *Rev. méd.-chir. de mal du foie*, 9: 331-87, 1934.
  36. ROME, A. W. Endocrine studies XXXV. The association of hepatic dysfunction with thyroid failure. *Endocrinol.*, 17: 1-22, 1933.
  37. BEAVER, D. C. and PEMBERTON, J. The pathologic anatomy of the liver in exophthalmic goiter. *Ann. Int. Med.*, 7: 687, 1933.
  38. WELLER, C. V. Hepatic pathology in exophthalmic goiter. *Ann. Int. Med.*, 7: 543, 1933.
  39. YOUNG, J. B. and WARFIELD, L. M. Liver injury in\* thyrotoxicosis as evidenced by decreased functional efficiency. *Arch. Int. Med.*, 37: 1-17, 1926.
  40. ASSMANN. Cited by Wilensky. Occurrence, distribution and pathogenesis of so-called liver death and for the hepatorenal syndrome. *Arch. Surg.*, 38: 625-691, 1939.
  41. MAHORNER, H. R. Jaundice associated with hyperthyroidism. *New Orleans M. & S. J.*, 87: 382, 1934.
  42. BOYCE, FRED F. The Role of the Liver in Surgery. Baltimore, 1941. Charles C. Thomas.
  43. JUDD, E. S. The physiology of the liver and its relation to surgery of the biliary tract (Trimble Lecture). *Ann. Surg.*, 90: 1035-45, 1929.
  44. PICKHARDT, O. C., BERNHARD, A. and KAHN, I. L. The significance of the cholesterol partition of the blood serum in surgery of the gallbladder. *Ann. Surg.*, 110: 701-722, 1939.
  45. SPERRY, W. M. Relationship between total and free cholesterol in human blood serum. *J. Biol. Chem.*, 114: 125-133, 1936.
  46. BARTELS, E. C. Serum-protein studies in hyperthyroidism. *New England J. Med.*, 218: 289-294, 1938.
  47. COHN, ALLAN and FREEDMAN, S. The relation between the liver and the thyroid gland. *Am. J. Clin. Path.*, 13: 27-31, 1942.
  48. MARUNO, Y. Experimental studies on halogen excretion from the liver. On excretion of bromine and iodine from the liver. *J. Gastroenterol. Dis.*, 3: 97, 1931.
  49. YUZURIHA, T. Iodine metabolism with particular reference to the significance of the role played by the reticulo-endothelial system. *J. Chosen Med. Ass.*, 25: 1059, 1271, 1498, 1935.
  50. DE COURCY, J. L. Iodine content of blood in cholecystic disease. *Arch. Surg.*, 35: 140-47, 1937.
  51. BOYCE, F. and McFETRIDGE, E. M. Studies of hepatic function by the Quick hippuric acid test: II thyroid disease. *Arch. Surg.*, 37: 427, 1938.
  52. CONNELL, F. G. Liver death. Rapid high temperature deaths. *Ann. Surg.*, 100: 319-27, 1934.
  53. CRILE, G. and CRILE, G., JR. Individualization of the patient in the treatment of hyperthyroidism. *Cleveland Clin. Quart.*, 2: 23-36, 1935.
  54. DINSMORE, R. S. Factors influencing morbidity in thyroid surgery. *J. A. M. A.*, 109: 179-183, 1937.
  55. DINSMORE, R. S. and HARRIS, I. E. Management of complications and emergencies in thyroid surgery. *Surg. Clin. North America*, 17: 1529-40, 1937.
  56. LAHEY, F. H. Reduction of mortality in hyperthyroidism. *New England J. Med.*, 213: 475-479, 1935.
  57. LORD, J. W. and ANDRUS, W. DEW. Changes in the liver associated with hyperthyroidism; with a study of plasma prothrombin levels in the immediate postoperative period. *Arch. Surg.*, 42: 643-660, 1941.
  58. FRAZIER, C. H. and NORTH, J. P. Carbohydrate metabolism in hyperthyroidism. *Tr. Am. Ass. Study of Goiter*, pp. 203-209, 1933.
  59. FRAZIER, C. G. et al. The thyroid and the liver. *West. J. Surg., Obst. & Gynec.*, 43: 636-646, 1935.
  60. FRAZIER and FREEMAN, H. Alterations in liver glycogen following thyroid, iodine and glucose feedings. *Surg., Gynec. & Obst.*, 60: 27-29, 1935.
  61. FRAZIER and RAVDIN, I. S. The use of vitamin B<sub>1</sub> in the preoperative preparation of the hyperthyroid patient. *Surgery*, 4: 680-86, 1938.
  62. BARTLETT, W., JR. Effects upon blood amylase of variations in thyroid activity. *Proc. Soc. Exper. Biol. & Med.*, 36: 843-48, 1937.
  63. BARTLETT, W., JR. Role of the liver in thyrotoxicosis. *Surgery*, 3: 261-62, 1938.
  64. PERRAZZO. Quoted by Boyce.<sup>42</sup>

65. SHAEFFER, J. M. Disease of the liver in hyperthyroidism. *Arch. Path.*, 29: 20, 1940.
66. WEBSTER, B. and CHESNEY, A. M. *Am. J. Path.*, 6: 275, 1930. Quoted by Boyd.
67. MARINE. Cited by Boyd.
68. BOYD, WILLIAM. *Surgical Pathology*. Philadelphia, 1943. W. B. Saunders Co.
69. ASHER, L. and DURAN, M. Beiträge Zűr Physiologie der Drüsen: XLIV. Das Verhalten von normalen, mit Schilddrüsensubstanz gefütterten und schilddrüsenlosen Ratten gegen reinem Sauerstoffmangel. *Biochem. Ztschr.*, 106: 254, 1920.
70. STREULI, H. and ASHER, L. Beiträge zur physiologie der Drüsen: XXXVI. Das Verhalten von schilddrüsenlosen milzlosen, schilddrüsen und milzlosen Tieren bei O<sub>2</sub>—Mangel, Zugleich ein Beitrag Zur Theorie der Bergkrankheit. *Biochem. Ztschr.* 87: 359, 1918.
71. BEST, C. H. and TAYLOR, N. B. *The Physiological Basis of Medical Practice*. 2nd ed., p. 468. Baltimore, 1940. Williams & Wilkens Co.
72. REINWEIN, H. and SINGER, W. Studien über die Gewebsatmung: iv. Der Einfluss von Thyroxin adrenalin und Insulin auf den Sauerstoffverbrauch überlebender Leberzellen. *Biochem. Ztschr.*, 197: 152, 1928.
73. McIVER, M. A. and WINTER, E. A. Increased susceptibility to chloroform poisoning produced in rats by injection of crystalline thyroxin. *Proc. Soc. Exper. Biol. & Med.*, 45: 201, 1940; *J. Clin. Invest.*, 21: 191, 1942.
74. McIVER, MONROE and WINTER, ELEANOR. Deleterious effects of anoxia on the liver of the hyperthyroid animal. *Arch. Surg.*, 46: 171-185, 1943.
75. LEWIS, R. A., THORNS, G. W., KOLFF, G. F. and DORRANCE, S. S. The rôle of the adrenal cortex in acute anoxia. *J. Clin. Invest.*, 21: 33, 1942.
76. EVANS, G. The effect of low atmospheric pressure on the glycogen content of the rat. *Am. J. Physiol.*, 110: 273, 1934.
77. EVANS, G. The adrenal cortex and endogenous carbohydrate formation. *Am. J. Physiol.*, 114: 297, 1936.
78. FARRANT, R. Hyperthyroidism: its experimental production in animals. *Brit. M. J.*, 2: 1363, 1913.
79. GERLET, F. Nécrose due foie consécutive a l'empoisonnement par la thyroxine. *Ann. d'anat. path.*, 10: 555, 1933.
80. HABAN, G. Leberveränderungen bei experimentellem Hyperthyreoidismus. *Beitr. z. path. Anat. u. z. alleg. Path.*, 95: 573, 1935.
81. COLCOCK, BENTLEY. A review of the pathogenesis and surgical treatment of thyroid disease. *Surgery*, 10: 336-357, 1941.
82. COLE, W. H. and BRUNNER, R. Anesthesia in thyroidectomy for thyrotoxicosis. *Surg., Gynec. & Obst.*, 70: 211, 1940.
83. SCHNEDORF, J. G., McCLURE, R. D. and McGRAW, A. B. Rationale and use of oxygen in the post-operative treatment of hyperthyroidism. Quoted by Colcock.
84. HAINES, S. F. and BOOTHBY, W. M. Oxygen treatment with special reference to treatment of complications incident to goiter. *Am. J. Surg.*, 7: 174, 1929.





# FIBROMATOUS SKIN LESIONS PRODUCED BY REPEATED BLOOD SERUM INJECTIONS IN THE HUMAN\*

WALLACE MARSHALL, M.D.

Associate Professor of Physiological Chemistry, Spring Hill College

MOBILE, ALABAMA

AT the New Orleans meeting of this group about a year ago, the author described some research<sup>1</sup> which was accomplished with an experimental liver extract which was administered to patients who had developed scars from acne. This paper described a "shrinking" of these scars through the process of vasoconstriction which the experimental material produced. The paper described the same action on keloidal growths.

In a previous communication<sup>2</sup> Rosenthal and Marshall wrote that tissue fluid extravasations might cause the proliferation of fibrous tissue in wounds, since blood serum escaped from the keloids when these were subjected to vasoconstriction through the use of this experimental liver extract.

Furthermore, Marshall and Greenfield<sup>3</sup> showed that tissue fluid extravasations, which follow extensive burns, can be checked by pressure dressings. This has decreased the production of keloids which accompany, at times, the healing processes in extensively burned skin areas.

This paper is intended to outline a theory on the pathogenesis of fibromas and their related structures. Further evidence will be presented which supports this viewpoint.

If scars can be partially shrunk in size with extrusion of inspissated serum, one may be able to introduce serum in normal skin and produce a tumor, for it may be this serum which may be at least partially responsible for fibrous tumor growth.

## THEORY OF POSITIVE CHEMOTROPISM FOR FIBROMATOUS GROWTH

Dorland<sup>4</sup> defines chemotropism as "the tendency of cells to turn or move in a

certain direction under the influence of chemical stimuli. When the movement is toward the substance exerting the chemical influence, it is termed positive chemotropism; when away from the influence it is negative chemotropism."

The author has noted that Virchow and Cohnheim, and later Nicholas Senn<sup>5</sup> advocated the theory of tumor formation from an embryonic matrix of cells. Much was written about the force which held in check the growth of these embryonic rests. This force was called "physiological resistance." Hence, when the tumor matrix, or embryonic rest, began to grow, it was thought that this physiological resistance was diminished or suspended.

In contrast to the above theory, I wish to offer my theory of positive chemotropism, since the escape of tissue fluids from their normal vessels, such as in the case of blood serum extravasations, seems to exert a definite chemotropic response. This inspissated tissue fluid seems to have the ability to attract fibroblasts. These cells infiltrate such areas which contain this foreign matter of blood serum, and in the course of time, these fibroblasts, as you well know, form scar tissue. The rapidity of this fibromatous growth may depend, among other properties, on its location and whether or not it happens to be sealed by an epidermal covering. If the growth encounters relatively loosely woven or firm structures, these may enhance or confine its growth.

As Moore has stated,<sup>6</sup> "There is no sharp line of distinction between hyperplasia of connective tissue in repair and neoplasia of fibroblasts; hence there are a number of conditions which resemble fibromas but which should not be so

\* This paper was read for the author by Dr. Alfred W. Harris, of Dallas, Texas, before the Southern Section of the American Federation of Clinical Research in that city on February 2, 1945.

designated. Some use the term 'pseudoneoplasms' for them."

*The Present Experiments.* In order to test the author's theory of positive chemotropism in fibroblastic growth, it was deemed advisable to simulate the production of tissue extravasation with injected serum. This would necessitate repeated small injections of blood serum, which at their best, could not duplicate the delicate natural mechanism of diapedesis in the living tissue spaces. As my former teacher Christopher aptly puts it: "The lymph of the exudate is derived from the blood, and represents an outflow so great that the lymphatics are unable to cope with it, so that it accumulates in the tissues. The amount of the lymph depends partly on the nature of the tissue (open or dense) in which the exudate occurs. In some forms of inflammation it forms the bulk of the exudate, e.g., in the sting of an insect."

The purpose, then, of the present experiments was to introduce blood serum repeatedly into normal skin tissues in order to determine whether or not a chemotropic influence could be exerted upon fibroblasts so that they would be attracted to the site of injury and begin the laying down of scar tissue. If this could be accomplished, an entirely new view might be given to the pathogenesis of benign neoplasms such as fibromas, desmoids, keloids, morphea, and other related tumor masses. Furthermore, if one could produce fibromatous growths at will, additional information would be available as to their prevention.

*Luetagin Injections on Author.* In order to test the theory of positive chemotropism, which the author supports, blood serum from a "Wassermann-fast" case was used. Although this blood serum was at least three years old, it was preserved with  $\frac{1}{2}$  per cent phenol and was deemed to be in good condition and certainly not injurious, since it had been subjected previously to several measures which rendered it non-infectious. This material had been employed in a series of experiments for skin-testing normal and syphilitic patients<sup>8</sup>

and I employed this material for my own injections since I had no equipment at the time to process the serum from myself. This serum was called "luetagin" since it was prepared from a syphilitic case.

The right thigh of the author received  $\frac{2}{10}$  cc. of luetagin, given intracutaneously, while the left thigh received the same amount of saline (physiological). Both materials contained  $\frac{1}{2}$  per cent phenol as a preservative. Thoroughly aseptic methods were followed rigidly to avoid infection. The injections began February 24, 1944, and were repeated in the identical areas on February 25, 29, March 1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12 and 13. Then no further injections were performed. Both areas were observed daily. A definite small tumor mass was continually observed in the experimental site, while the control area remained negative. On May 14, 1944, under aseptic surgical technic, and with novocaine anesthesia, both the control and experimental areas were extirpated by myself, placed in separate labelled glass vials, which contained 10 per cent formalin. These were mailed to Dr. Rosenthal, Milwaukee, Wisconsin, for examination.

*Pathological Report.* No fibromatous changes were noted in the control block of tissue. The experimental site contained a small section of tissue which had undergone fibrosis. Microphotographs and lantern slides of both the control and experimental sites have been prepared by Dr. Rosenthal. (Figs. 1 and 2.)

The pathologist's report is as follows: "*Luetagin Experiment:* Sections taken from the control and test areas and stained with hematoxylin and eosin revealed no change in the epithelium of either area. However, in the subepithelial tissue definite differences can be detected. The test area exhibiting condensation and thickening of collagen material in the subepithelial tissue was further confirmed by Masson trichrome stains."

*The Second Series of Injections in the Human.* Instead of employing luetagin, as in the first set of injections on the author,

it was deemed highly advisable to prepare the blood serum directly from the author's blood. Hence, 20 cc. were withdrawn by

infiltration. Each section was again placed in separate vials which contained 10 per cent formalin as a preservative. These were

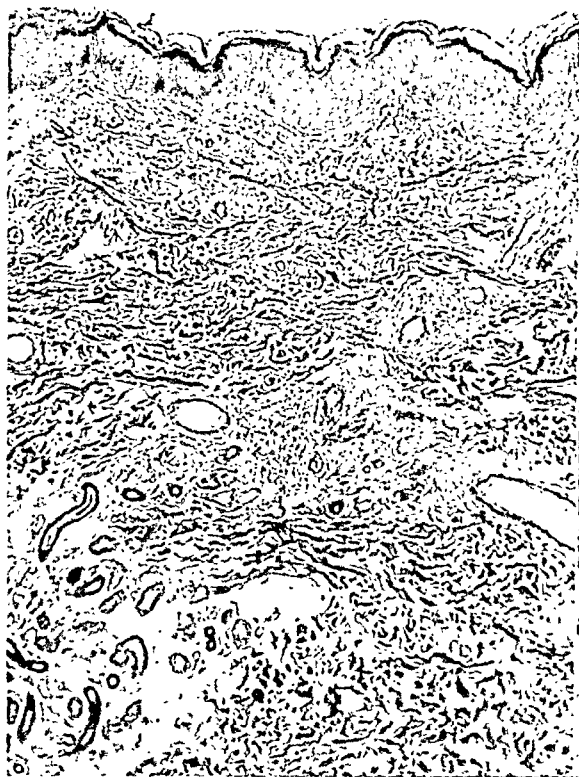


FIG. 1. (Control.)



FIG. 2. (Tumor.)

FIGS. 1 AND 2. Luetagin experiment. Note Figure 2 (tumor section) showing condensation and thickening of collagen material in the sub-epithelial tissue with obscuring of the capillaries. Changes not seen in Figure 1 (control section).

the author, and the blood serum was preserved with  $\frac{1}{2}$  per cent phenol in rubber-capped vials. Again, aseptic technic was employed throughout the procedures.

On January 8, 1945, the author began serum and control (saline) injections of  $\frac{3}{10}$  cc. in opposite portions of the thigh two inches above the original sites of extirpations. Again, both the experimental (serum) and the control (physiological saline) solutions each contained  $\frac{1}{2}$  per cent phenol as a preservative. From the above date through January 17, 1945, the author administered fourteen sets of injections (control and experimental). On January 20, 1945, both sites were removed by the writer under aseptic surgical conditions with the use of a novocaine

sent again to Dr. Rosenthal for pathological studies.

It should be reported that the experimental site bled much more freely than did the control site when the injection areas were extirpated. I take it that the blood supply was increased at the site of the tumor mass.

*Pathologist's Report.* As in the first sets of sections, the control area was normal while the experimental area contained a larger area of fibromatous tissue than was noted in the tissue which was treated with luetagin. Photomicrographs and lantern slides have been prepared from these tissues by Dr. Rosenthal. (Figs. 3 and 4.)

The pathologist's report is quoted as follows: *Human Serum Experiment (Author):*

Sections taken from the control and test areas of skin reveal no changes in the epithelium in either instance. In the

## COMMENTS

From the experimental findings, it appears that repeated injections of blood

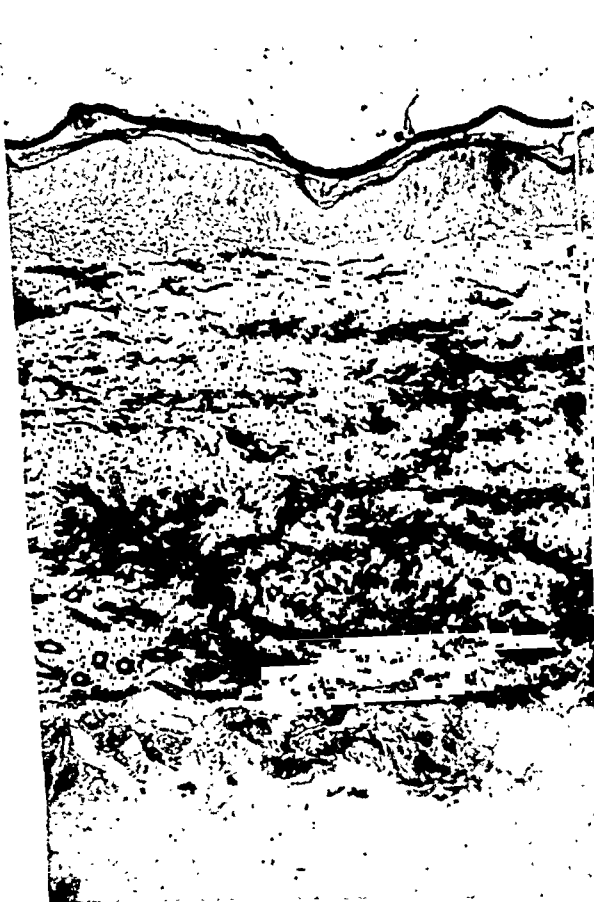


FIG. 3. (Tumor.)



FIG. 4. (Control.)

FIGS. 3 AND 4. Experiment with author's blood serum. Note Figure 3 (tumor section) showing pronounced condensation increase and thickening of sub-epithelial collagen material with thickening of capillaries and diminution in number. Changes not seen in Figure 4 (control section).

subepithelial tissue the test area, however, shows changes not seen in the control area. The changes consist of very marked thickening, condensation and marked increase of collagen material. In addition, there is diminution in the number of capillaries and thickening of their walls. These changes are much more pronounced in the human serum tissues than they are in the tissues injected with Luetagin. The nature of the condensed material in the subepithelial tissue was further confirmed by Masson trichrome stains.

Changes seen are similar to those found in early human keloids.

serum have the ability to attract fibroblasts. This supports the author's theory of active chemotropism in the pathogenesis of fibromatous tumors. To the writer's knowledge, this constitutes the first series of experiments which have produced such tumors from blood serum alone.

The fact that tissue plasma is so abundant in burned areas, which are notorious for their ability to develop hyperplastic scars and keloids, leads us to the opinion that the elimination of this swelling of the tissue spaces by compression, in such injuries, is a sound therapeutic measure.

Professor R. A. Moore, of Washington University Medical school,<sup>9</sup> has observed

an extensive fibrous mediastinitis in a negro male at autopsy. This further points to massive exudations of serum in the medias-

Furthermore, it does not seem impossible to visualize the formation of hypertrophic scars and keloids from our experimental

TABLE I  
SCHEDULES OF INJECTIONS ON AUTHOR WITH LUETAGIN

Date	Amt. of Luetaquin Cc.	Amt. of Saline (Control) Cc.	Observations
2-24-44	0.2	0.2	
2-25-44	0.2	0.2	
2-26-44	0.2	0.2	
2-28-44	0.2	0.2	Persistent induration noted in exp. area
2-29-44	0.2	0.2	Induration persists in exp. area
3-1-44	0.2	0.2	
3-2-44	0.2	0.2	
3-3-44	0.2	0.2	Definite soreness over exp. area, induration does not disappear; control area negative
3-4-44	0.2	0.2	
3-5-44	0.2	0.2	
3-6-44	0.2	0.2	
3-7-44	0.2	0.2	No soreness in exp. area to injection; felt definite resistance to needle; control area negative
3-8-44	0.2	0.2	
3-9-44	0.2	0.2	
3-10-44	0.2	0.2	Both areas bleed freely following injections
3-11-44	0.2	0.2	
3-13-44	0.2	0.2	

Seventeen injections administered in each area. 5-14-44: Both areas extirpated by author under local anesthesia. Experimental area appeared more vascular during surgery than did control area.

tinum which may have exerted a positive chemotropic action on fibroblasts with the consequent laying down of fibrous deposits in such an area. This view is supported further by the case reports of Hamman and Rich<sup>10</sup> who, among other findings, reported an extensive, diffuse and progressive interstitial proliferation of fibrous tissue throughout all lobes of both lungs. They reported that the cause of the disease was unknown; but with our present findings, it does not seem too absurd to think that a massive exudation of blood serum occurred in these patients which may well have produced the fibrotic changes in these lungs.

TABLE II  
SCHEDULES OF INJECTIONS WITH AUTHOR'S BLOOD  
SERUM

Date	Hour	Amt. of Serum Cc.	Amt. of Saline (Control) Cc.	Observations
1-8-45	12:20 P.M.	0.2	0.2	Experimental injection more painful
1-8-45	3:05 P.M.	0.2	0.2	Serum not so painful this time
1-8-45	5:00 P.M.	0.2	0.2	
1-9-45	3:30 P.M.	0.2	0.2	Definite induration per- sisted since last injec- tion at experimental site
1-10-45	1:45 P.M.	0.2	0.2	Exp. area became pain- ful 30 seconds after in- jection; induration in experimental area pers- ists; control area nega- tive
1-10-45	4:45 P.M.	0.2	0.2	Neither injection painful
1-11-45	10:00 A.M.	0.2	0.2	
1-11-45	4:10 P.M.	0.2	0.2	
1-12-45	10:00 A.M.	0.2	0.2	Stinging at exp. site about 30 sec. following injection; exp. site con- tinually indurated; con- trol negative
1-13-45	12:00 A.M.	0.2	0.2	Exp. area bleeds follow- ing injection
1-15-45	1:30 P.M.	0.2	0.2	
1-16-45	11:30 A.M.	0.2	0.2	
1-16-45	3:55 P.M.	0.2	0.2	Fluid escaped at sites of both injections; needle met with resistance at exp. site, control nega- tive
1-17-45	2:00 P.M.	0.2	0.2	Redness over exp. area

Fourteen injections administered in each area. 1-20-45: Both areas extirpated by author under local anesthetic. Experimental area appeared much more vascular and indurated than control area.

findings. If fibromas of the skin are related to hypertrophic scars, at least pathologically, and the empiric distinction is made between hypertrophied scars and keloids, in that these scars are excessive productions of fibrous tissue within the limits of the wound, while the latter is exactly the same process plus a similar invasion of the surrounding skin,<sup>11</sup> it appears to the author that all of these pathological processes may have a similar pathogenesis. It may well be that the concept of active chemotropism may aid future research in such conditions. At any rate, the above research can be repeated easily by those who wish to observe and study the formation of these

fibromas for themselves. It would be well to remove these tumors at regular intervals in order to study these changes in relation to the time factor. The author has not been able to induce his nurses, nor patients to submit to such studies. It is hoped that other medical colleagues will not meet with such sales resistance.

#### SUMMARY

The basic work, which led to the author's concept of positive chemotropism, is reviewed. Tissue fluid extravasations seem to attract fibroblasts, which actively lay down connective tissue, when blood serum is injected into normal skin tissue. The author does not favor the concept of tissue rests which have been thought to form neoplasms. Rather, it is evident that blood serum has the property to attract fibroblasts which may form fibromas when blood serum invades the cell spaces of skin.

The author has described two sets of experiments. The first employed serum taken from a "Wassermann-fast" case. Although this particular serum was three years old, it led to the formation of a small fibromatous lesion when this serum was injected intradermally repeatedly. The control site, which received similar amounts of saline, remained negative.

Serum taken from the author and injected repeatedly intracutaneously, caused the formation of a larger fibromatous area than did the three-year old serum taken from the luetic case. The control site, which received similar saline injections, remained negative.

Microscopic evidence has been obtained which shows that subepithelial changes similar to those seen in keloids can be produced experimentally by the injection of serum into the subepithelial tissues.

The fact that the experimental sites, after six days, opened wide after the sutures were removed, points to a widespread injury of the adjacent tissue not involved by the tumors. This was not evident in the control areas. Further work is being done on this subject by Dr. Rosenthal, and at a later date, he may be able to present some pertinent information as to why these experimental areas were so delayed in healing and why they bled so profusely during extirpation of the tissues.

The author is grateful to Dr. Samuel Rosenthal, of Marquette University Medical School, Milwaukee, Wisconsin, for the pathological studies which he performed for this research.

#### REFERENCES

1. MARSHALL, W. Production and treatment of scars and keloids. *New Orleans M. J.*, 97: 15, 1944.
2. MARSHALL, W. and ROSENTHAL, S. Pathogenesis and experimental therapy of keloids and similar neoplasms in relation to tissue fluid disturbances. *Am. J. Surg.*, 62: 348, 1943.
3. MARSHALL, W. and GREENFIELD, E. Modified non-adherent gauze pressure treatment for burns. *Am. J. Surg.*, 63: 324, 1944.
4. DORLAND, W. A. N. *American Illustrated Dictionary*, 14th Edition, p. 256, 1927.
5. SENN, N. *The Pathology and Surgical Treatment of Tumors*. P. 64. Philadelphia, 1895. W. B. Saunders.
6. MOORE, R. A. *A Textbook of Pathology*. P. 187. Philadelphia and London, 1944. W. B. Saunders Company.
7. CHRISTOPHER, F. *Textbook of Surgery*. 3rd. ed., p. 4. Philadelphia, 1943. W. B. Saunders Company.
8. MARSHALL, W. Luetagin serum studies of immunologic reactions in normal and syphilitic patients. *J. M. A. Alabama*, 12: 335, 1943.
9. MOORE, R. A. Personal communication.
10. HAMMAN, L. and RICH, A. R. Acute diffuse interstitial fibrosis of the lungs. *Bull. Johns Hopkins Hosp.*, 74: 177, 1944.
11. IVY, R. E. *Military Surgical Manual: Manual of Standard Practice of Plastic and Maxillofacial Surgery*. Philadelphia and London, 1943. W. B. Saunders Company.



# DISSECTING ANEURYSM OF THE THORACIC AORTA DUE TO TRAUMA

DONALD W. LEONARD, M.D.

Associate Surgeon, Mary McClellan Hospital

CAMBRIDGE, NEW YORK

THE pathological condition known as *aneurysm* is, by definition, an abnormal, circumscribed, blood-containing cavity communicating with an artery. Classification upon the basis of gross anatomy can be made with a minimum of controversy by a simple scheme which has apparently been acceptable since presented by Herschfelter:<sup>4</sup> (1) True aneurysms, (a) sacculated, (b) fusiform; (2) dissecting aneurysms; (3) false aneurysms; (4) arteriovenous aneurysms; (5) cirroid aneurysms.

These various types may occur in almost any artery but there is obviously a greater likelihood in certain localities as is indicated by figures compiled from a series of 530 aneurysms discovered at autopsy as quoted by Ridge:<sup>8</sup>

Thoracic aorta.....	175
Popliteal artery.....	137
Femoral artery.....	66
Abdominal aorta.....	59
Carotid artery.....	25
Subclavian artery.....	23
Axillary artery.....	18
External iliac artery.....	9
Cerebral artery.....	7
Common iliac artery.....	2
Posterior tibial artery.....	2
Gluteal artery.....	2
Pulmonary artery.....	2
Brachial artery.....	1
Subscapular artery.....	1
Ophthalmic artery.....	1

More recent reviews of the subject would undoubtedly add several more locations to the list and alter the proportions but it is certain that the incidence of aneurysm would still be greatest in the thoracic aorta.

The location of any aneurysm is determined largely by its etiology. It can be assumed that those of traumatic origin will appear most frequently in the exposed

superficial vessels, while from the fact that syphilis attacks the thoracic aorta most actively, aneurysms from that cause would almost always be found in the mediastinum. Since aneurysms of the aorta are disorders of a large artery which is well protected from outside influences, it is to be expected that the development of an aneurysm in this location will usually be due to intrinsic arterial wall damage either from degeneration or disease. Tabulations bear out this reasoning and it has been estimated that 90 per cent of all aortic aneurysms are due to syphilis.<sup>8</sup> A summary of the distribution of types of aortic aneurysms may be obtained from an analysis of figures collected by Riffin<sup>9</sup> from the literature and from the post-mortem records of the Massachusetts General Hospital. A rearranged tabulation of his figures is as follows:

Number of autopsies analyzed.....	9600
Number of aortic aneurysms found.....	116
Types:	
True dissecting aneurysms.....	17
Small "dissections" around plaques.....	13
True aneurysms:	
Ascending aorta.... 21	} Total thoracic 66
Aortic arch..... 37	
Descending aorta... 8	
Abdominal aorta..... 20	
Total thoracic.....	86
Etiology:	
Thoracic aneurysms { Syphilitic.....	60
Arteriosclerotic.....	3
"Senile ectasia".....	3
Abdominal aneurysms { Syphilitic.....	3
Arteriosclerotic.....	17

## DISSECTING ANEURYSMS

The above figures appear to cover the entire question of aortic aneurysm but there is a notable lack of attention paid to the group designated as *dissecting aneurysms*. Elsewhere in the literature this matter has been discussed<sup>1,2,3,5,7,10</sup> and the

"spontaneous" development of dissecting aneurysms has been explained upon the basis of defective arterial walls and abnormal hydrostatic pressures.<sup>6</sup> It has been stated that the underlying factor is degeneration of the middle coat and that arterioma is not a common cause. Dissecting aneurysms are almost never seen to start in the abdominal part of the aorta where the grossest arteriomatous ulcers are found.<sup>2</sup> Syphilis plays little or no part<sup>10</sup> but senile dilatation without arteriosclerosis has been emphasized.<sup>9</sup> Once the microscopic damage has been done the lesion begins as a penetration of the circulating blood into the substance of the wall of the vessel with subsequent extension of the effused blood for a varying distance between the layers. The sac thus formed communicates with the original lumen of the artery at the point where the intima was first ruptured and after extending to its limit, the new space may become thrombosed, may break again into the original lumen of the artery or, more commonly, may rupture into an adjacent space such as the pericardium or the pleural cavity.

The partial rupture of the aortic wall and the formation of a dissecting aneurysm may, however, develop in a healthy aorta if the causative factor in the form of trauma is severe enough.<sup>10</sup> This last situation is undoubtedly one of the rare forms of a rare condition and Samson,<sup>10</sup> discussing this condition in 1931, stated that only "about a hundred" cases had been reported up to that time (1895 to 1931). Additional examples of traumatic dissecting aneurysm of the thoracic aorta have been mentioned from time to time in American medical publications with a vagueness that defies analysis.<sup>7,10</sup> The impression one obtains is that the proof of the traumatic etiology is usually somewhat presumptive and that the development of the dissecting aneurysm is considered to have been due to some remote trauma in the absence of evidence of any alternate cause.

In view of the fact that dissecting aortic aneurysms caused by trauma are rare and

that the evidence of the traumatic etiology is usually unsatisfactory, it has seemed worth while to present with this discussion the history of a patient who entered the Mary McClellan Hospital in November, 1944, as a routine automobile accident casualty with injuries which were thought to be obvious. Like so many cases of dissecting aneurysm, his condition was not recognized before death,—probably entirely due to the fact that this diagnosis was not considered. In the literature the record of anti-mortem diagnosis is so poor that McGreachy,<sup>6</sup> in 1937, was bold enough to say that of the 500 cases of all types of dissecting aortic aneurysm on record only nine had been recognized before autopsy. This author made a point of reporting three more which had been recognized before death and other authors have followed suit by reporting their successes with just pride. The diagnosis can, therefore, be made in many cases of spontaneous dissecting aneurysm once the differentiation between coronary thrombosis,<sup>1,12</sup> perforated peptic ulcer and acute pleurisy has been made, but it will be seen that when the dissecting aneurysm is the result of recent trauma, the distinguishing symptoms may be completely masked by the ordinary evidences of the accident itself.

#### CASE REPORT

The patient, a sixty-year-old man, weighing 150 pounds, was admitted to the hospital less than twelve hours after an automobile accident. Looking back into his hospital record it was found that official information began in 1932 when he was forty-five years of age. At that time he reported having had severe influenza in 1918 and two rib fractures, the latest in 1932. There were no complaints relative to the cardio-respiratory system but a story of chronic (fifteen years) digestive disturbances led to his being admitted to the hospital in 1932 for study. As a result of examinations a diagnosis of chronic cholecystitis had been made on the basis of x-ray studies of the gallbladder while a gastrointestinal x-ray series demonstrated a normal stomach and duodenum. The routine examination of his heart showed no enlarge-



ment, murmurs, or thrills and the rate and rhythm were stated as being normal. The blood pressure was 124/74.

The patient was not again seen until June, 1940, when he reported with an infected finger for which he was again admitted to the hospital. On the record of this admission mention was again made of the chronic stomach distress and intermittent right upper quadrant abdominal pain. The presence of dyspnea, palpitation or chest pain was specifically denied and the heart and lungs were normal to examination. The blood pressure was 158/78 and the blood Wassermann reaction was negative (June 1940).

At the time of the present admission the patient brought his past history up to date by reporting the loss of two fingers from the right hand by gunshot injury three years before, a "nervous breakdown" one year before and an infection of the right leg six months before. His family contributed the information that he had never been troubled with dyspnea, palpitation, chest pain or cough and that he had worked energetically on the highway until the winter lay-off a few weeks before. They also stated that he was temperate both in the use of alcohol and tobacco.

The accident which caused his final admission to the hospital occurred while the patient was driving his own car in complete possession of his faculties and in perfect health. A collision of three automobiles took place and the patient was pinned between the steering wheel and the back of the driver's seat so that considerable difficulty was encountered in extricating him from the wreckage. In the process he was heard to complain bitterly of a severe pain in the anterior region of his chest as well as in the region above his left knee where deformity and abnormal mobility indicated a fracture. He was taken to a nearby hospital where a Thomas splint with fixed traction was adjusted and he was then transferred in a few hours to the Mary McClellan Hospital. Examination showed some superficial skin abrasions on the anterior wall of his chest with sufficient underlying pain to restrict breathing and indicate that trauma had been received on the left anterior chest wall extensive enough to have caused at least a contusion of the tissues of the thoracic cage. There was also an epigastric distress as an extension of the pain in the chest and the presence of a comminuted fracture of the left femur was

verified by x-ray. The patient's blood pressure was 150/70.

During the patient's first three days in the hospital he ran a temperature and developed the familiar picture of accumulated bronchial secretions so often associated with the pain-inhibited respiratory movements of an injured chest. Bronchopneumonia was feared and sulfathiazole given. It was repeatedly apparent that the patient breathed with difficulty when flat, and for partial relief, his head was elevated as much as the restrictions of the fracture apparatus would allow. Two readjustments of the fracture were made after the initial fever had subsided, each time with spinal anesthesia. On the first occasion the blood pressure was noted as 122/90 (November 10th) and the second time as 140/80 (November 18th). After November 10th, the fractured member was suspended from an overhead frame and a trapeze provided so that with his arms the patient was able to lift his shoulders and hips for the routines of bed care. The fact that he could do this encouraged the belief that the injury to the chest was not very extensive.

The patient remained with treatment directed primarily toward the reduction and maintenance of the fractured bone for fifteen days. The chest pain eased on the fourth day but the cough on exertion and the orthopnea persisted without evidence of the gradual improvement experience would lead one to expect from injury as serious as a rib fracture. Otherwise there was nothing which could have given warning of the impending dramatic death.

During the early part of the day of his death the patient appeared as usual. An effective routine enema had been given in the morning but at about 4 P.M. there was a rather unexpected and urgent desire to defecate. Inasmuch as the patient was at that moment in conversation with the author, he joked about this unexpected activity and demonstrated complete good humor as the bed curtains were drawn and he proceeded to have a satisfactory bowel movement. Without again opening the curtains the nurse began the routine evening care which involved the usual rolling from side to side in which the patient helped himself by lifting with both of his hands on the overhead trapeze provided for him. This routine finished, he was preparing to use the mouth wash when he was observed to lose color

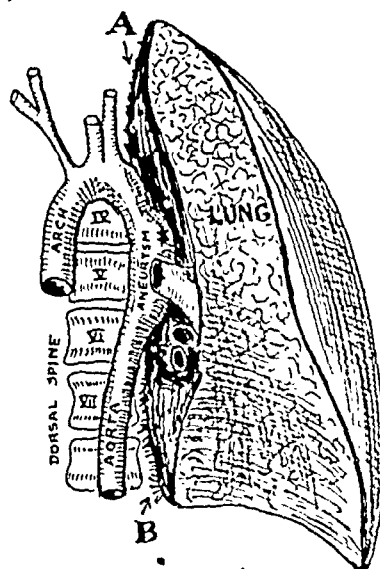
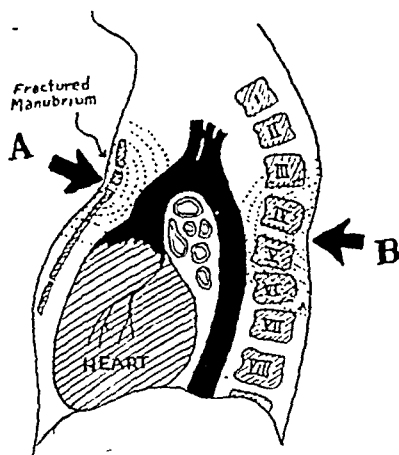
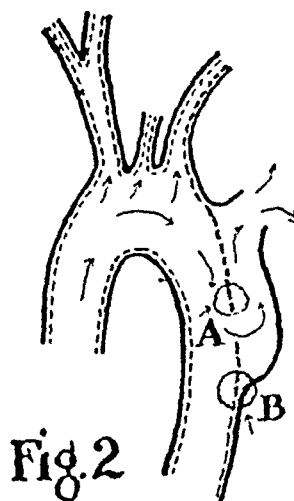
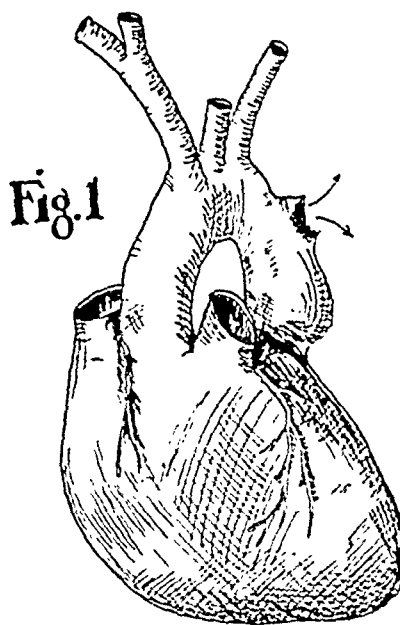


FIG. 1. Heart and aortic arch showing location of dissecting aneurysm in the first part of the descending aorta. Through the point of secondary rupture (marked by arrows) blood was pumped directly into the left pleural cavity to cause sudden death fifteen days after automobile accident.

FIG. 2. Schematic longitudinal section through the aortic arch showing the media as a broken line and the adventitia as a solid line. These two layers have been separated by the dissection of the aneurysm and the points of primary and secondary rupture are as indicated. Microscopic sections taken at points "A" and "B." (Figs. 5 and 6.)

FIG. 3. Diagrammatic median sagittal section through the thorax to show the mechanism of distortion due to squeezing forces "A" and "B" which caused fracture of the manubrium and injury to the aorta.

FIG. 4. Sketch to show the relationship between the aneurysm of the aorta and the neighboring dorsal spine. Pleural adhesions found along the posterior margin of the left lung are indicated between points "A" and "B."

suddenly. His motions were instantly arrested and consciousness faded with a rapidity so startling that no clue was ever obtained as to

it covered the vertebral bodies. (Fig. 4 A-B.) Beneath the parietal pleura along this same line there seemed to be a discoloration due to

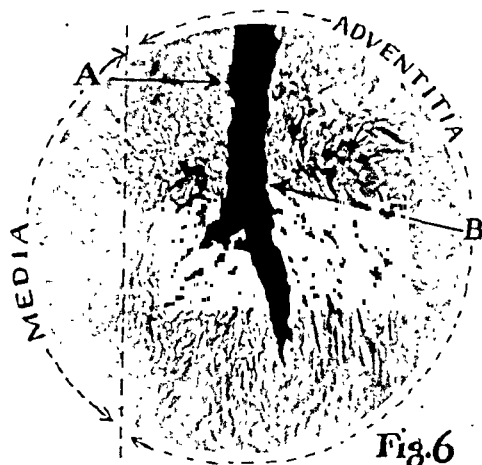
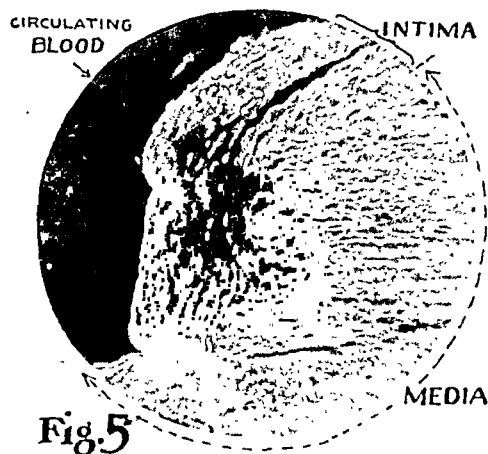


FIG. 5. Microphotograph of the arterial wall at the point of primary rupture. (Fig. 2 "A.") Elastic tissue of the media has been sharply broken without evidence of previous degeneration. Retraction of these fibers and probably some proliferation of the intima has covered these ends. (Note: A negative print of the enlargement has been used to accentuate the structural elements. Dark area to the left may be considered the cavity of the aneurysm filled with blood.)

FIG. 6. Negative print of a microphotograph at the point where separation is progressing. (Fig. 2 "B.") Dissecting blood space appears black and the separation of the layers is seen to be advancing through the adventitia close to its junction with the media. There is no degeneration or tissue reaction near the split and the cavity of the aneurysm shows no intimal lining either on the side toward the lumen of the aorta (A) or toward the outer layers of adventitia (B).

what sensations he may have experienced. His breathing came to a complete stop after a few seconds of jerky chest movements and in the time it took to get a stethoscope into action his heart had stopped beating. Some adrenalin was injected hurriedly into what should have been his pericardium but proved to be entirely futile and death was pronounced in less than two minutes after the start of the spell.

An autopsy was done about four hours after death in order to clarify the relationship of his death to the automobile accident. The most significant findings were those in the thorax which was opened in the usual manner by removal of the sternum and costal cartilages, demonstrating in the process that a hitherto unsuspected transverse fracture through the manubrium was present. The left pleural cavity was found to be filled with blood clot compressing the left lung almost completely and pushing the heart and mediastinum to the right well beyond the midline. A further clarification of the situation disclosed a line of fresh adhesions fixing the entire posterior border of the left lung from apex to base to the parietal pleura where

extravasated blood extending from the region of the thoracic vertebral bodies downward for a short distance below the diaphragm. After clearing the clot from the left thoracic cavity it was found that the bleeding had not come from any chest wall injury but had escaped from an irregular opening in the upper mediastinal pleura where further exploration demonstrated a dissecting aneurysm of the first part of the descending aorta at a point adjacent to the body of the fourth dorsal vertebra. (Figs. 1 and 4.) The capacity of this aneurysm was estimated as having been about 50 cc. and the dissection had encircled the aorta for about two-thirds of its circumference on the left and anterior aspects. The pericardium, heart valves and blood vessels were grossly normal. The abdomen showed no significant disorder and, interesting enough, the gallbladder and bile ducts were also normal. Specimens were removed for microscopic examination.

The pathologist described the specimen of the aneurysm as a piece of the descending aorta whose lining showed wrinkling and arteromatous changes without definite calcification.

On the convex side the media was described as having been dissected away from the adventitia and the cavity produced partly lined with fibrin and a small amount of blood clot. Sections were obtained from the artery at the point where the dissection was advancing and from the media at the margin of the original rupture. (Fig. 2.) A complete description of the histology is presented in the legends for Figures 5 and 6.

#### COMMENT

It is believed that, to a unique degree, the circumstances of this case present proof that a dissecting aneurysm of an essentially normal aorta can be caused by transmitted trauma. There must be, in a physical sense, a very fine difference in the amount and direction of forces which will in one case tear completely through the aorta and produce instantaneous death and in another case split only the inner coat to start the development of a dissecting aneurysm whose eventual fatal rupture is delayed. It may be admitted that any such event as a partial rupture of the inner coat would be more likely to happen from trauma in an aorta already diseased or degenerated so as to be on the verge of spontaneous rupture. It is perhaps for this reason that experienced physicians universally express a desire for proof that trauma and trauma alone can bring it about. The rôle of trauma in the production of dissecting aneurysms of the aorta seems to be mentioned in every text book discussion of the subject of aneurysms but a sensitive reader can feel the scepticism in the author's words as he strives to make his account academically complete by some such phrase as, "Trauma must be mentioned on a account of the peculiar cases in which rupture due to trauma is not accompanied by any external marks or even by fracture of the ribs or other injury,"<sup>5</sup> or "The location of the lesion suggests that the aorta might have been previously damaged by syphilis in spite of the negative blood Wassermann reaction."<sup>7</sup>

It might be well to repeat some of the

observations made by Samson<sup>10</sup> who seems to have been one of the few to concentrate seriously upon the matter of traumatic dissecting aneurysms of the aorta. His statements published nearly fifteen years ago are interesting in comparison with observations made in the case history herewith reported and the close agreement of the two provides evidence that the entity is still appearing as it did in his day. Speaking of dissecting aneurysms in general, Samson repeated the opinion that syphilis was a rare cause of the condition although it might be seen in a small number of cases as a coincidental finding. Samson also remarks that traumatic aneurysms of the aorta are practically all dissecting and while relatively more rare than the spontaneous type, they would be seen more frequently because of the increased number of industrial and automobile accidents. These generalizations fit our case but inspection of medical references does not seem to indicate that the condition is being reported with any greater frequency. Samson adds that traumatic dissecting aneurysm may occur in a healthy aorta and that the aneurysm is generally formed at the time of the accident or immediately following. He lists severe blows on the chest by large, blunt forces and crushing chest injuries with fractured ribs as causes of the initial rupture of the inner layer of the aortic wall. With all this our case also agrees. Samson points out that the commonest location for the first injury is just above the aortic valves and tries to indicate that due to the presence of the ligamentum arteriosum, the posterior wall of the aorta is at this point relatively more fixed so that it may be crushed against the vertebral column to receive the brunt of any impact. In our case the rupture would not appear to have depended upon any such anatomical factor; severe local injury apparently came from the nature and direction of the force itself.

In the case which we have reported the circumstances of the accident and the regions showing evidence of tissue damage

present unquestionable proof that the trauma was a squeezing of the thoracic cage between an anterior force represented by the steering wheel of the patient's car and a force from behind represented by the back of his seat. (Fig. 3.) The force from the front (Fig. 3A) caused a sharp depression which resulted in a transverse fracture of the manubrium at a point directly anterior to the aortic arch. The other force from behind (Fig. 3B) caused a broader pressure giving probably a local hyperextension with some tearing of the anterior longitudinal ligaments of the spine in the region of the fourth dorsal vertebra against which the first part of the descending aorta lay. There may have been a sudden flattening or angulation of that vessel so that at that point the initial rupture of the intima occurred as a direct result of the trauma. Traumatic inflammation of the neighboring pleural surfaces would account for the adhesions along the posterior border of the left lung.

During the course of this man's illness certain symptoms were evident which, in retrospect, can be recognized as those of the dissecting aortic aneurysm. A tearing pain referred to the anterior chest and a certain degree of shock were both characteristic<sup>1,2,3,6,11,12</sup> but were indistinguishable from the same symptoms which might have been entirely due to the trauma itself. The cough and dyspnea on exertion together with the orthopnea were less characteristic of chest trauma and should perhaps have been the clues to the real diagnosis. The quiescent period of relative comfort after the first shock is known to occur in cases of dissecting aneurysm but the absence of progressive improvement beyond this point should have suggested that something other than uncomplicated chest trauma was back of it. Finally, the dramatic death came, and if the possibility of dissecting aneurysm had been considered, this would have settled the point conclusively. Somehow the diagnosis of pulmonary embolism seems to be the

first to enter the minds of the startled attendants when death comes thus suddenly, but a second thought would show many obvious differences. It is hoped that this report of a well authenticated case of traumatic dissecting aneurysm of the thoracic aorta will provide stimulus for that second thought.

In conclusion it might as well be noted that the prognosis in dissecting aortic aneurysm is bad whatever the cause. Samson<sup>10</sup> estimated that 65 per cent die instantly and that about 15 per cent more died suddenly in the next few days. The small number that survived probably developed a "healed aneurysm" by virtue of a blood clot or a rupture back into the original lumen of the aorta. East<sup>2</sup> repeated the calculation that 80 per cent of the patients die in the first few days. Taking this bad prognosis into consideration it becomes important not to mistake a dissecting aneurysm of the aorta for coronary thrombosis, perforated peptic ulcer or acute pleurisy even in the absence of external injury and to entertain, as a result of this faulty diagnosis, any ideas about surgical treatment or hope for the relatively favorable prospects of these other conditions.

#### SUMMARY

A brief review of the subject of dissecting aneurysms of the aorta due to trauma has been presented as a result of interest aroused by the postmortem diagnosis of a case following death from injuries received in an automobile accident. From the fact that the rôle of trauma in the production of aneurysms of the aortic arch is so incompletely discussed in medical literature, it is concluded that the condition is a rare variety of a relatively rare pathological entity and that complete clinical facts of such a case will therefore be of interest. That this fatal condition may be present after an automobile accident even when the aorta was previously normal becomes an important consideration for any physician who handles such accidents and who

may at any time be involved in the resulting litigation.

## REFERENCES

1. BLACKFORD, L. M. and SMITH, C. Coronary thrombosis vs. dissecting aneurysm in differential diagnosis. *J. A. M. A.*, 109: 262-264, 1937.
2. EAST, TORENCE. Dissecting aneurysm of the aorta. *Lancet*, pp. 1017-1019, Nov., 1939.
3. GARDNER, E., GALBRAITH, A. J. and HARDWICK, S. W. A huge dissecting aneurysm. *Lancet*, p. 1019, Nov., 1939.
4. HERSCHFELDER, A. D. Diseases of the Heart and Aorta. Philadelphia, 1918. J. B. Lippencott Co.
5. INGLBY, H. Sudden Death Cyclopedia of Medicine, Surgery and Specialties. Vol. 4, p. 696. Philadelphia, 1939. F. A. Davis Co.
6. McGEACHY, T. E. and PAULLIN, J. E. Dissecting aneurysm of aorta. *J. A. M. A.*, 108: 1690-1698, 1937.
7. Queries and Minor Notes. Dissecting aneurysm, *J. A. M. A.*, 115: 635, 1940.
8. RIDGE, F. J. Aneurysms. *J. Missouri M. A.*, 29: 456-462, 1932.
9. RIFFIN, M. DE G., CASTLEMAN, B. and WHITE, P. D. Arteriosclerotic aneurysms and senile ectasia of thoracic aorta. *Am. Heart J.*, 22: 458, 1941.
10. SAMSON, PAUL C. Dissecting aneurysms of the aorta, including the traumatic type: three case reports. *Ann. Int. Med.*, 5: 117-130, 1931.
11. WHITE, J. C. Painful aneurysms of the aortic arch: relief by paravertebral injections of procaine and alcohol. *J. A. M. A.*, 99: 10-13, 1932.
12. WHITE, P. D., BADGER, T. L. and CASTLEMAN, B. Dissecting aortic aneurysm wrongly diagnosed coronary thrombosis. *J. A. M. A.*, 53: 1135-1139, 1934.



*A deficient circulation of blood accompanies some arterio-venous aneurysms; the results include general weakness of the limb, early fatigue on exertion, and perhaps swelling and pain when the limb is dependent—symptoms which resemble those following closure of the main venous channels. A special and noteworthy feature is the speed with which the swelling disappears after elevation of the affected part.*

From "Surgery of Modern Warfare" edited by Hamilton Bailey (The Williams and Wilkins Company).

# THE USE OF WHOLE SKIN GRAFTS AS A SUBSTITUTE FOR FASCIAL SUTURES IN THE TREATMENT OF HERNIAS\*

## PRELIMINARY REPORT

GEORGE B. MAIR, M.D.

ABERDEEN, SCOTLAND

**B**RIGADIER EDWARDS,<sup>1</sup> in the *British Journal of Surgery*, has exposed in masterly fashion the modern views on the treatment of inguinal hernia.

The position is that the Bassini operation, with all its modifications, is not only inefficient, but actually harmful, and should be abandoned. In its stead there are two alternatives, each with its indications. The first, or physiological, in which a simple herniotomy with high excision of the sac is combined with repair of the torn or weakened fascia transversalis, and the second, or plastic, in which living fascial sutures are used to narrow the internal abdominal ring, and to strengthen the weakened posterior wall of the inguinal triangle. One is in full accord with the view that a study of the history of hernias is recommended to all who have been, or may be persuaded into designing and perfecting a new method of cure for this age-old deformity; and one further agrees that improvement will come, not from the evolution of more operations, but from careful attention to technic, pre- and post-operative care, selection of the most suitable method of repair for each case, and increase in the technical skill of the operator. Despite that, the author believes that in the method to be described here there is a promise of good results.

Edwards' paper should be read as a background to this, which is distinctly a preliminary report suggesting that the use of whole skin grafts inlaid under extreme tension and in such a fashion as to protect the posterior wall of the inguinal canal, and narrow the internal ring, may

be superior to fascia in most respects. The method has been used for cases in which fascia was formerly indicated, and a history of the investigations which have been in progress in Aberdeen during the past year will be detailed.

First, however, it is necessary to discuss the position which the use of fascia holds, and to note its advantages and disadvantages. Thus it may become clear that there is room for further improvement, and therein lies the justification for suggesting a new method.

### USE OF FASCIA IN HERNIAS

McArthur, in 1901, introduced the use of living fascial sutures for repair of inguinal hernias, but since that time the method has not been so extensively accepted as it deserves, and comparatively few surgeons have adopted it as a routine measure. McArthur utilized strips cut from the aponeurosis of the external oblique muscle, and applied them following the principles of Bassini or Halstead.

In 1910, Kirschner<sup>2</sup> developed the technic, and used strips of fascia, or a plaque of fascia lata, cut from the thigh. Since then the only outstanding contribution has been made by Gallie and LeMesurier<sup>3</sup> who further advanced Kirschner's method and published their work in 1921.

Gallie and LeMesurier threaded strips of fascia lata through special needles and interwove them between the conjoined tendon and Poupart's ligament. They showed that the fascia excited no inflammatory reaction, that it survived for many years, united with the tissue in which

\* From the Woodend-Oldmill Hospitals, Aberdeen, Scotland.

it was embedded, and, owing to its great tensile strength did not stretch under pressure as does ordinary scar tissue. The use of the special needle folded the fascia into rounded cords which, in the course of a few weeks became surrounded by a film of vascular areolar tissue. From this film, septae of similar tissue penetrated the spaces between the folds and into the adjacent structures, to effect firm union, and form a dense plaque of firm fibrous tissue.

At the end of three weeks any individual fascial cord had the appearance on section of a structure closely resembling that of normal tendon.

In 1940, McCloskey and Lehman,<sup>4</sup> and also Joyce,<sup>5</sup> attempted to stimulate further interest in the use of fascia, and emphasized that it should not be reserved exclusively for very large and very difficult hernias, but should be used for all in which a repair other than the physiological type was indicated. Joyce advocated it for all primary direct and indirect inguinals, all femoral, and for all types of recurrent, also umbilical and ventral. This is going somewhat too far, because, as Edwards and many others have emphasized, where the abdominal rings are not dilated, where the muscles have retained satisfactory tonus, where the canal has not been stretched, and where the patient is young and healthy, by far the best results are obtained by high excision of the sac, and repair of the transversalis fascia combined with re-education of the muscles at an early stage in the postoperative period.

The indications for the use of fascial sutures are: (1) All recurrent herniae of any type; (2) all primary direct inguinals; (3) all primary oblique inguinals, where there is muscle atrophy and weakness of rings and posterior wall; (4) all funicular or "saddle bag" types; (5) as the final stage in the Mayo repair of umbilicals, and (6) as the final step in repair of large ventral or incisional hernias.

It is thus recognized that fascia is reserved for those cases which are most

likely to recur, and in those subjects whose physique is prejudicial to the success of a physiological repair. It might then be expected that cases dealt with by fascia would show the higher recurrence rate.

*Recurrence Rates.* Follow up recurrence figures show very wide variation in different clinics, in the same clinic with different surgeons, and are influenced by many variable factors. An optimistic and self-deceiving eye may discount a small painless bulge over the scar, where the critical analyst would accept it as an early failure. Figures based upon questionnaires are reliable only up to a point. In my own series, most of the patients were examined personally by myself, and were also asked the questions of a questionnaire sent to others. The difference between facts, and the patients' opinions was striking. Twenty per cent of all those with recurrence were unaware of the fact. This is a common experience in most clinics.

Despite the difficulties attendant upon acceptance of published figures, certain facts emerge clear. The recurrence rate varies in the case of indirect inguinal hernia, up to 30 per cent with an accepted average of 12 per cent. Max Page,<sup>6</sup> in a series analysed in 1934, found that there was a recurrence rate of 20.5 per cent as against 12 per cent in 1942. The reason for the improvement lay in the adoption of more conservative methods of treatment in the earlier type of case.

McCloskey and Lehman<sup>4</sup> analyzed the results in different American Clinics, and found that with Bassini operation and its modifications, recurrences varied from between 5 and 20 per cent for the indirect types and between 7 and 42 per cent for the directs.

When fascia had been used, recurrences varied in different clinics from 3 to 4 per cent for the indirect, and between 7 and 9 per cent for the direct varieties. These figures are representative of extremes found in a number of different clinics, but it is clear that the use of fascia, though it



be in the less favorable type of case, definitely reduces the incidence of recurrence.

Much depends upon the time interval before re-examination. It is accepted that at least 75 per cent recur within the first year, and at least 60 per cent within the first six months.<sup>6-9</sup>

When allowance has been made for variable factors, fascia still emerges from the test as being the best available method for those patients who require repair. The results are good, and one may be asked what valid reason there is for attempting to use other substances.

*Disadvantages of Fascia.* Fascia does have certain disadvantages. These will be briefly indicated:

1. The McArthur method does not give enough fascia to fulfil the requirements of the average case, and is applicable mainly to the inguinal type. For a large hernia the method is not ideal.

2. The Gallie technic involves either an extensive wound in the thigh, or a small incision combined with the use of a fasciotome. In either case there is a risk of postoperative pain referred to the thigh and hip joint of the affected side, and the possibility of obvious muscle hernia. This pain may be quite intractable and last for many years. It is aggravated by exercise, and, in my experience occurs in 25 per cent of subjects, though to a widely varying degree, and in none is it so severe that life is made intolerable for the sufferer, nor does he desire another operation for its relief.

The etiology of this pain is obscure, and is not necessarily due to muscle hernia, because it is not always cured by repair of this condition. The pain has a definite bearing upon the use of fascia, and in those cases of hernia in which a workman's compensation suit is impending, or in Service personnel, may be a great annoyance.

3. Infection of the wound in the abdomen is more common after this method of herniorrhaphy than by others. Bendick<sup>10</sup> found sepsis to be present in 7.9 per cent of his cases in which autogenous fascia had

been used, and in 12.1 per cent in which ox fascia was used. Beekman and Sullivan<sup>11</sup> admit the increased liability of sepsis in fascial operations owing to the increased operating time necessary for their performance. In my own series of 120 fascial repairs mild sepsis developed in five, and moderate sepsis in two. In one, healing was delayed till the thirty-fourth day, but all the others were healed with twenty-two days.

4. There is also an increased liability to develop postoperative pulmonary complications, owing, it is considered, partly to the increased operating time, and partly to another factor. Churchill and McNeil<sup>12</sup> investigated the reduction in vital capacity following upon abdominal operations, and found that it varied with different types of operation and of incision. They established that there is a relationship between the incidence of pulmonary complications for a particular type of incision or operation, and the reduction in vital capacity associated with that procedure. Where there is plastic repair and reflex muscle spasm, the reduction in vital capacity is the more marked. In simple herniotomy this is considerably greater. The relative incidences of postoperative "chest" is in accord with this finding.

5. Fascia will unite to fascia under considerable tension<sup>13</sup> and it may be applied under tension to unite the conjoined tendon to Poupart's ligament, or, it may be darned loosely between the two structures. In either case there are potential gaps between the strands of fascia, and not always do all the strands unite with one another. Potential gaps exist, and recurrences, as in the case of Bassini, develop mainly in the form of the direct type.

In the patients with recurrences operated upon by myself after previous fascial repair, with one exception the sacs have been of the direct variety, and found close to the medial aspect of the canal. In several, the sac had clearly insinuated its way through a gap in the fascial strands which in other parts had effected a powerful reinforcement.

6. The needle used for the Gallie method is large, and apt to traumatize the inguinal ligament. The significance of this is obscure, but an impression exists that it may predispose to formation of direct or femoral recurrences.

There is also an appreciable risk of penetrating the femoral vein. This complication has been frequently mentioned in the literature,<sup>14</sup> and has occurred, I am confident, on many more occasions than have been reported. This may be an extremely difficult hemorrhage to control, and in one which came to my notice, death resulted on the operating table.

7. Finally, there remains a substantial recurrence rate, and the figures quoted above may be regarded as the best available. Even there, the figure for the direct variety is too high, and in the hands of many surgeons the figures are considerably higher for both types. It will surely be admitted by all that even the best figures available are still too high, and provide room for consideration as to how they may further be reduced.

In an attempt to overcome the risks of sepsis, Koontz,<sup>15</sup> Rosenblatt and Meyers,<sup>16</sup> Jalifier,<sup>17</sup> and Christophe<sup>18</sup> have all investigated the possibilities of using dead fascia which has been sterilized. Were such fascia proven to be effective, time would be saved during the operations and postoperative sepsis and "chest" would probably be fewer. The thigh incisions with their associated late pain and muscle hernia would be avoided.

A great deal of research has been done by these and other workers, but the method has not yet become popular, though it seems to be becoming more so in America. Nevertheless, the technic evolved does not affect the recurrence rates.

In conclusion it may be stated that fascia has been of great value in the treatment of direct and large hernias, that it is becoming more extensively used for those patients who formerly would have been given a modified Bassini repair, but that though the method has reduced

recurrence there is still room for further improvement. Finally, there is an associated higher incidence of postoperative sepsis and chest trouble, and the residual pain in the thigh which may affect a proportion of the subjects is a disability of significance.

#### CUTIS GRAFT REPAIR

Rehn<sup>19</sup> and Loewe<sup>20</sup> advocated the use of a method known to them as the "cutis graft method for the repair of anatomical defects in postoperative herniae," and of these, Rehn was the first to apply the principle clinically. The term "cutis" was coined because, though derived from the skin, it is not a true skin graft, being defective in epidermis. Cutis contains all the elements of the skin excepting the epidermis, it is elastic, inherently active, and composed of a rich network of connective tissue fibers. After transplantation, according to Uihlein,<sup>21</sup> these inherent factors persist in the metamorphosis of the graft, and, owing to the stimulus initiated and maintained by the tension under which the graft is sutured, a metaplasia into stout connective tissue takes place.

Rehn and Schwartz, quoted by Uihlein,<sup>21</sup> performed a tenotomy of the tendo Achilles in a dog, and repaired the defect with cutis graft. They found that a gradual metamorphosis took place after ten weeks, into a tendon, difficult to differentiate from ordinary tendon. When the experiment was repeated with fascia, regeneration was slower, and repair less complete.

Eitel<sup>22</sup> showed quite conclusively that cutis lives longer, is more active than fascia, and is thus more suitable for plastic repair. He removed pieces of human fascia and cutis at operation, and performed metabolic studies upon them by the Warburg technic. His findings demonstrated the superior viability of cutis over fascia, and he determined that this fact held good for both sexes and for all age groups.

Rehn applied his cutis graft, which he took from the thigh, into the defect

FIG. 1.



FIG. 2.

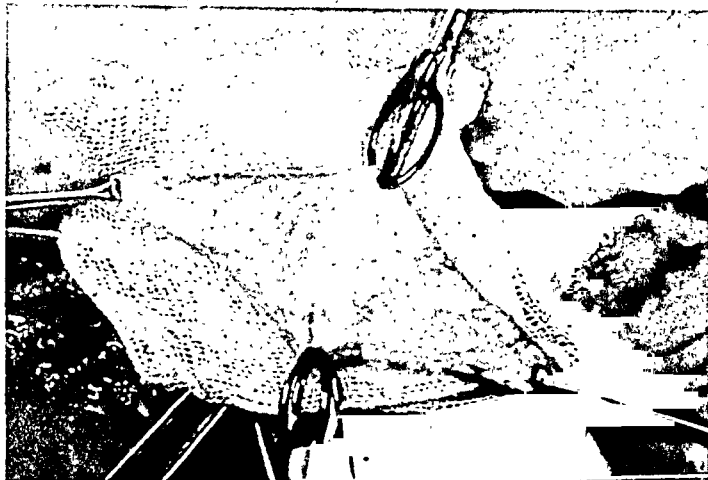


FIG. 3.

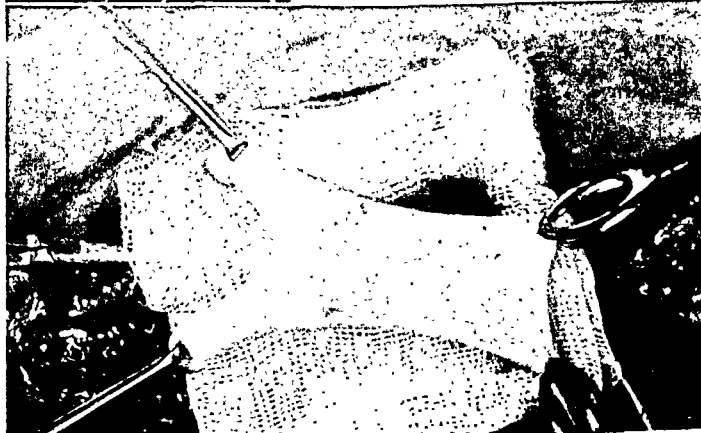


FIG. 1. The incision has almost been completed and the ellipse is ready to be freed and lifted out.

FIG. 2. The graft is shown fatty side upward and ready for preparation.

FIG. 3. The graft has been prepared and shaped. It is shown with the superficial surface upward.

requiring plastic repair, and attached it under a maximum degree of tension to its surrounding structures by interrupted

cyst formation, either macro- or microscopic. He did, however, note the presence of large cells with clear deeply staining



FIG. 4.



FIG. 5.

FIG. 4. The graft has been anchored medially. The two tails of skin held by forceps embrace the internal ring.

FIG. 5. The graft has been sutured into position, and the two skin pedicles approximated lateral to the internal ring. The new ring formed of skin is clearly shown overlying the muscular one deeply.

sutures. The graft was cleared so far as possible of epidermis.

Uihlein was afforded the opportunity of operating upon two patients who had submitted to a cutis graft repair four years earlier. Sections were removed for examination. He found that there was a complete metamorphosis of the transplant. The grafts represented normal connective tissue with its fibrous and fatty components, blood vessels and nerves. No hair follicles or glandular tissue could be identified, and there was no evidence of

nuclei and lying in rows or in rings. These were interpreted as being remains of hair follicles or glands, surrounded by giant cells, macrophages and lymphocytes. No scar tissue was seen in the sections examined.

Rehn used this method in sixty-five gross postoperative hernias with six poor late results. There were a further thirty-nine operations in which cutis was used to fill in a tissue defect, and of the total of 104 operations for various purposes, fifteen were complicated by wound sepsis.

Cannaday<sup>23</sup> has described his experiences with cutis repairs in two contributions to the literature. He and his surgical associates in the Charleston General Hospital used the method in thirty-seven cases, of which twenty-seven were hernias of various types. Two operations were followed by mild sepsis and two by small hematomas. But these workers warmly applaud the principle, and state that it is superior to fascia. They find that the graft heals firmly and promptly, and commend the fact that it is easily obtainable in portions as large as necessary for any given case.

Neither Cannady and his co-workers, or Rehn and his associates have investigated with detail the histology of their grafts, but they are agreed that clinically the results are excellent. A good deal of work has been done by others in regard to cutis implants, though here they were not sutured under tension, but merely embedded into the body tissues. It may be that the different methods adopted to use the graft may be associated with variations in the histological findings. This question will be discussed later, but, for the moment it is necessary to consider the findings of these plastic surgeons who have studied the histology of cutis implants, remembering that these were buried grafts, but not sutured under tension.

Eitner,<sup>24</sup> and Peer and Paddock<sup>25</sup> have studied the subject at length. They found that despite every attempt to remove the epidermis, apices of hair follicles and sweat glands were still to be found in the grafts, and that when implanted, these structures disappeared and the grafts were gradually transformed into fibrous tissue. They found that the grafts fused with their surroundings through the mechanism of inflammation and repair associated with aseptic wound healing.

Peer<sup>26</sup> conducted a detailed investigation into the fate of cutis implants in a large series of nasal reconstruction operations. He stored pieces of derma with cartilage beneath the skin for periods up to two

years, and studied sections prepared from these at varying intervals. He observed a gradual degeneration of the normal skin structures, with disappearance of hair follicles and sweat glands at an early stage. These were replaced by fibrous tissue. The investigations raised the old question as to the danger of epidermoid cyst formation; and as this is an objection which is frequently raised to the use of cutis implants, it is well at this stage to consider it thoroughly.

Garre<sup>27</sup> made the observation that implantation of epidermis alone produced a smooth-walled cyst, whilst in the cyst rising from a dermal implant skin papillae were present in the wall. The comb of a cockerel has no hair follicles or glandular structures, and was thus selected as the object of an experiment by Kaufmann<sup>28</sup> in 1884. An elliptical incision into the comb was made and the edges of the wound closed over the enclosed ellipse of tissue. A cyst was formed, and it is evident that this could not have arisen from other than epidermal elements.

In the same year Schweninger<sup>29</sup> performed a similar experiment in a dog, producing a subcutaneous cyst. This type of cyst was found to contain in its lumen, cholesterol, epidermal scales and fat, while in the walls were found hairs and sebaceous glands.

Hesse<sup>30</sup> and Pels-Leusden<sup>31</sup> both produced implantation cysts by means of a foreign body embedded beneath the dermis, and both investigators agreed that the origin of the cyst was from glandular epithelium injured by the skin incision, and not related to the implantation of epidermal cells. These cysts contained all the layers of normal epidermis but no dermal elements.

Zimches<sup>32</sup> buried free strips of whole thickness skin into the muscles of dogs and studied the implants up to two years. His conclusions may be summarized: (1) The epidermis of the implant curves upwards in a u shape, the margins of the u meeting during the fourth week to form a

closed cavity lined with epithelium. (2) The cyst continues to grow because the lining epithelium constantly produces cornified cells which are shed into the lumen. Part of the content is made up of epithelial débris and broken down hairs. (3) Secondary cysts may develop from hair follicles. (4) The implanted section of skin heals in its new bed and rapidly fuses with its surroundings by means of granulation tissue later organized into tough fibrous tissue. (5) No metaplasia of epithelium was noted, and no malignancy observed at any stage.

From all of these and other experiments performed in animals, considerable argument can be developed against the method. In the human subject, however, the work of Peer and Paddock<sup>25</sup> opened up new avenues of consideration, and when combined with the clinical experience of Rehn, Cannaday and their associates, suggest that the method is entirely safe, and that the risk of later epidermoid cyst formation is remote. There is, however, as indicated above, a difference between merely laying in a cutis graft in a prepared bed, and suturing it to its attachments under as great a degree of tension as possible. Moreover, the pieces of cutis studied by Peer and Paddock were small by comparison with the sizes of graft required for many hernias, and it is reasonable to suppose that these two factors may modify the histology. The indications from Uihlein's two cases are that metaplasia follows much more rapidly where tension has been applied to the graft and that it is much more complete.

The method adopted by Rehn has clinically one decided disadvantage. The prepared thigh has an area of epidermis removed from it by a Thiersh razor, and from this denuded part the cutis graft is cut. The edges of the resulting wound are devoid of epidermis and are closed as well as possible. Yet healing is slow and, in any case, time is lost in the preparation of the graft.

The question arose in the author's mind

as to whether it was really necessary to remove the epidermis, and with that end in view he investigated the use of whole skin implants sutured under tension in rabbits and in guinea pigs. At the same time the operation has been applied clinically to a considerable number of hernias in which fascia otherwise would have been used. The results to date will be fully detailed.

#### WHOLE SKIN GRAFT IMPLANTS

In 1938, the author was confronted with the problem of closing and repairing a very large ventral hernia in a woman, aged sixty-four. For the first time he implanted a large whole skin graft, having excised and closed the redundant peritoneum. The graft was sutured to the anterior aspects of both rectus sheaths, and to the medial aponeurotic expansions of the external obliques. The graft measured some four inches by five inches, and was taken from redundant skin excised by an elliptical skin incision. The repair was firm and satisfactory. Eighteen months later there was no recurrence or other complication. Between 1938 and October 1943, a similar method of repair was adopted in seven large ventral, three umbilical, and one epigastric hernia. In none was there any complication during the postoperative period but, unfortunately owing to the War situation and the resultant migrations of myself and the population, none of the cases was followed up for more than a few months. The immediate results, however, had been so encouraging, that it was determined to apply the same method to the repair of inguinal hernias, and to investigate the histology of the implants.

*Histology of Grafts Applied to Rabbits and Guinea Pigs.* The rabbit was chosen as being a suitable animal for the work. An incision was made over the lumbar vertebral spines, the lumbodorsal fascia exposed and a portion excised. The defect was repaired by a whole skin graft cut from the edges of the wound, and sutured

under a high degree of tension to the adjacent aponeurosis. Two types were used: In the first, the hair was clipped away from the graft, but a coating of some 3 mm. in length was retained as a challenge to Nature's ability to deal with such a type of foreign body. In the second, the hair was removed as completely as possible, but the epidermis in both cases was undisturbed. Sections of normal rabbit skin were studied for comparative purposes. Sections examined were stained with hematoxylin and eosin, with Van Gieson's connective tissue stain and with Weigert's elastic tissue stain.

It was found that in the first group, in which the grafts had a coating of fine hair, in sections examined five months later, while sebaceous glands, hair follicles and epidermis had entirely disappeared, hairs had been surrounded by a massive foreign body reaction, and this in turn was being encapsulated off by a firm fibrous stroma. Macroscopically, at five months it was very difficult to determine the margin of the graft, this being so firmly attached to its surroundings, and so closely resembling dense normal fascia in appearance. The degree of metaplasia was striking.

Microscopically, however, dermal elements could be identified apart from the hair remnants. Atrophied sweat glands were detected, and a few dermal papillae in a similar state of degeneration. The dermis showed a dense infiltration with fibrous tissue and impressive degree of vascularity. The margins of the graft were firmly united to adjacent fibrous tissue, and vascular septae infiltrated deeply from the graft to subjacent muscle. A number of small rounded, and encapsulated structures were noted which appeared to be masses of cornified epithelium arranged in whorls.

In the second type of case in which the graft had been carefully shaved of hair, but in which epidermis had not been damaged, reaction was similar in essentials, but foreign body response was less intense. The grafts were all intensely vascular, hair

follicles could not be identified, sebaceous glands and dermal papillae were absent, and sweat glands were showing signs of advanced atrophy and fibrous tissue replacement.

In sections studied after three weeks the graft had materially altered macroscopically, and closely resembled white fibrous tissue. Microscopically, all elements of the skin could be identified, but a fibroblastic reaction was in process, and granulation tissue was apparent at the margins of the implant.

No trace of epidermoid cyst could be detected, and the epidermal tendency to elevate in U shape to form a cyst as described by Zimches<sup>32</sup> was absent. Instead, the epidermis was being desquamated and the cells and débris removed by phagocytes.

Sections removed at other stages showed features intermittent between the two extremes described.

Similar experiments were conducted in a number of guinea pigs. None of the animals survived for more than five days, but, in the sections examined, early infiltration with new blood vessels and round cells was noted and also commencing atrophy of hair follicles, with phagocytosis of epidermal débris and hairs.

The opportunity arose to explore an inguinal canal in the human subject, into which a whole skin graft had been sutured for a large direct hernia three months earlier. A Kodachrome color film was taken of the exposed canal, and it is hoped to be able to publish this in my next contribution on the subject. The graft was very firmly attached to Poupart's ligament, aponeurotic medial aspect of the internal oblique, and insertion of rectus sheath in the pubis. It was not possible to identify with assurance where the graft ended and normal tissues began, as the change into tissue closely resembling that to which the implant was sutured was so striking. The appearance closely approached that of a normal inguinal canal, and the dense fibrous tissue formation and

deformity of normal anatomy, which is so striking a feature of recurrent fascial hernias, was absent. It is difficult to imagine wherein the repair could have been improved. A section of the superolateral part of the graft was removed for examination. The histology was that of highly vascular connective tissue, in which no dermal or epidermal elements could be identified. The graft was richly infiltrated with collagen fibers, and there was firm adhesion to the underlying muscle. No trace of even microscopic cyst formation was found, but a number of giant cells were observed. No hair remnants could be identified.

The animal experiments are being continued, and in a later report the findings will be submitted. Let it suffice for the moment to say that sections have been examined at intervals up to ten months after implantation of the grafts in rabbits, and that the findings closely coincide with those of Peer and Paddock<sup>25</sup> in relation to cutis grafts. No contraindication to the use of the grafts in the human subject has been found by this method to date.

*Clinical Application of the Principle.* In a series of 119 inguinal hernias, direct, indirect and recurrent, six umbilical, ten ventral, one epigastric and one femoral, repair has been performed by means of a

whole skin graft. There have been two cases of mild sepsis which have cleared up, the first under three weeks and the second under four. One scrotal hematoma developed and there have been twelve cases of postoperative bronchitis, which cleared up within a few days.

The results have been satisfactory but, of course, much more time must elapse before recurrence figures can be submitted. So far as late postoperative complications are concerned there have been none so far, but these will be considered at a later date when more time has elapsed and more cases are available for analysis.

TECHNIC OF OPERATION

*Skin Preparation.* This is highly important. It is suggested that the skin chosen for the purpose, coming as it does from the vicinity of the symphysis pubis, is potentially infected, and that even if the surface be sterile, organisms may lurk in the depths of the hair follicles. Proof of the safety of using this skin lies in the results of experience. The method has been used in 137 cases with impunity.

The method of skin preparation is first of all by careful shaving followed by scrubbing with ether soap and warm water for ten minutes. Spirit compresses and a sterile double hip spica bandage are then applied. The procedure is repeated daily for three days in all.

Before operation, in most of my cases, a culture of organisms from the skin was taken. Only a few showed any growth, and these mainly scanty colonies of *Staphylococci albus*.

*Anesthetic.* The anesthetic of choice, is, in my view, gas oxygen and ether with preliminary premedication of omnopon and scopolamine 3/4 cc. Local anesthesia is perfectly suitable, and I have done a few with it. The disadvantage is that it is essential for this operation that the muscles be completely relaxed, otherwise, when the graft is in position and apparently under tension, further muscle relaxation reduces this tension, and vitiates the

TABLE I

Type of Hernia	No.	Average Age
Indirect inguinal.....	80	45
Recurrent indirect inguinal.....	2	27.5
Direct inguinal.....	28	43
Indirect-direct.....	9	48.5
Umbilical.....	5	44.0
Recurrent umbilical.....	1	55.0
Ventral.....	10	39.9
Epigastric.....	1	38
Femoral.....	1	39

TABLE II  
COMPLICATIONS

Sepsis.....	2 cases, cleared 21 to 28 days
Chests.....	7 cases bronchitis, mild
Others.....	1 scrotal hematoma, cleared.



entire principle of the technic. For ideal relaxation an inhalation anesthetic is essential. The exponents of spinal anesthesia may use it if they desire.

*Incision.* This is elliptical, the superior limb starting over the symphysis pubis, and curving upward with the concavity downward, toward the anterior superior spine for a distance of three and a half to four inches. The inferior limb commences over the external abdominal ring at the first incision, and extends upward and in a lateral direction with a slight downward convexity. These incisions are fashioned to enclose an ellipse of skin which is at least two inches long, and approximately one inch wide at the broadest diameter.

The skin with attached subcutaneous tissue is removed, and immersed in warm normal saline solution until required.

The external oblique is incised in the usual way and the flaps reflected to expose the inguinal canal and spermatic cord. The superior flap of the aponeurosis is detached for a distance of approximately one-half inch from its pubic connection, in order the better to expose the area to which the graft will be sutured medially. This having been done, the cord with cremaster muscle is lifted from the canal, and both are separated clearly from the floor and from adhesion to the inguinal ligament from the internal ring to the pubic end. It is essential to clear the area thoroughly, and this is readily done by clean firm sweeps with a gauze swab.<sup>33</sup>

The cremaster and coverings of the cord are incised in the usual way, the sac dissected clear, and removed by ligation and excision at as high a level as possible. In this connection it is sound to follow the method of Millér,<sup>34</sup> or ensure high ligation by rotating the structure and transfixing it just distal to the deep epigastric vessels. The sac must always be transfixed, and never merely ligated as the risk of such a ligature slipping is very real. In most old or large hernias there is an area of constriction or scar tissue on the peritoneum of the sac. This is firmly adherent to the

adjacent cord; and if it is considered to be the true neck, and ligation performed at that level, the risk of recurrence is increased, as the apex of the stump is bound to the cord outside the internal ring, and its retraction is restricted.<sup>35</sup> This fibrous attachment must be freed and it must be ensured that the freed stump will retract to as high a level as possible. It is ill advisable to suture the stump to the anterior abdominal wall as it causes necrosis of muscle fibers bound into the anchoring suture, and prevents high retraction of the stump.<sup>36</sup> Absorbable gut should be used for the purpose.

The next step is to buttress the fascia transversalis, and to narrow the pillars of the internal ring by carefully inserted sutures. The importance of the fascia transversalis can hardly be over emphasized. In earlier days the importance attached by Bassini to the conjoined tendon tended to remove attention from this important fascia, but, in actual point of fact Bassini himself made much of the step, and it is his pupils rather who overlooked it. Wyllis Andrews<sup>37</sup> visited Bassini's clinic and described the technic as practiced during his visit. He made it clear that the first deep suture of Bassini, included the transversalis fascia in order to narrow the internal ring. In even earlier days, Cooper and Scarpa<sup>38</sup> clearly understood the significance of this fascial layer and brought out the fact in a textbook on the subject. When this line of sutures has been inserted, a firm support for the graft is fashioned, and internal ring is narrowed, and an added protection against later direct recurrence provided.

The repair of the incision in the coverings of the cord is made with a running suture and attention turned to the graft.

The ellipse of skin will be found to have shrunk considerably in size. The extremities are seized by Allis forceps and the subcutaneous fat rapidly dissected away. The pointed extremities of the ellipse are then chopped off, so as to leave a free end of at least one-third of one inch at one end,

and one-quarter at the other. The larger end is then incised vertically along from its mid-point for a distance of approximately one-half to three-quarters of an inch, and each tail of skin grasped at its tip by an Allis forcep. The whole is then laid into the inguinal canal and the inferior forcep placed below the retracted cord. The forceps are then pulled upward and laterally so that the apex of the v thus formed grips the internal ring.

The medial margin of the graft is sutured by three stitches, to the lower anterior aspect of the rectus sheath, the fascia over the symphysis pubis, and the extreme medial edge of Poupart's ligament. Care is taken that the graft is stretched taut and that it well overlaps the pubis and rectus.

The superior Allis forceps is then drawn gently but firmly upward and laterally to stretch the superior edge of the graft tightly. The end of the skin pedicle is then sutured to the medial aponeurotic expansion of the internal oblique. The lower skin pedicle is then also drawn outward and the extremity sutured to the shelving inner margin of Poupart's ligament at least one-half inch above the level of the internal ring. Sutures are placed at intervals of about one-quarter of an inch along the lower edge of the graft to anchor it to Poupart's ligament, and care is taken that the ligament is sutured as near the floor of the canal as possible. The final row is applied to the superior edge of the graft, and fixes it to the aponeurotic medial edge of the internal oblique very close to the lateral margin of the rectus sheath.

The outer aspect of the graft is then sutured, joining the two pedicles together lateral to the internal ring, and in such a fashion as to form a skin plaque lateral to it as well as medial, forming another ring of skin over the internal muscular ring, and causing the cord to arch slightly upward in its course from the ring to the canal.

In inserting the superior row of sutures, and those joining the two skin pedicles,

care is taken to ensure that the graft is sutured under great tension to its attachments. When they have been inserted, the skin is white and blanched, tightly drawn over the floor of the canal, and in close apposition to the buttressed fascia transversalis with no dead space between.

Thirty-day chromicized catgut is used for suturing the graft. In my experience linen is inferior to catgut for most purposes, and this is the experience of many surgeons. Longacre<sup>39</sup> and Maingot<sup>40</sup> adopt a contrary view, and the subject is open to discussion.

A fine layer of sulfonamide powder is insufflated on to the surface of the graft and the surrounding tissues, the external oblique is closed, a running suture applied to the fascia of Scarpa and Camper and the skin sutured with interrupted fine silk gut.

The closed incision is angled like a hockey stick medially, and this hockey stick type of incision has found favor with several workers.<sup>41,42</sup> It is reputed to be kept more readily free from infection, to facilitate dressing, and to be more comfortable from the patient's point of view.

Finally, a hip spica bandage is applied with the hips slightly flexed and in the position of physiological relaxation of the inguinal muscles, as so often advocated by Lyle.<sup>43</sup>

Sutures are removed on the eighth day, movements are allowed in bed after the fourteenth, and the patient is allowed up on the twentieth day. It is established that fascia requires three weeks to heal firmly, and there can be no point in permitting freedom of movement before that day. There are sufficient recurrences without adding to the already numerous risks.

In this description of technic, no mention has been made of the many difficulties which may confront the operator; lipomas in the canal, the "saddle bag" type of hernia, where there are both direct and indirect in the same subject, grossly atrophied musculature, the complete congenital scrotal or sliding varieties, and so forth. The intention has been to describe

the application of the method to a straight-forward type of case. But, it is emphasized, that as the whole skin graft is advocated for use in large and difficult cases, it follows that difficulties will be encountered, and they are all readily capable of being surmounted by this new method.

The same principles can be adopted for direct hernias, and can easily be used as a final reinforcement for umbilicals, ventral or epigastrics, and in fact, one of the main attractions is the general applicability of this method to any type of hernia.

#### COMMENT ON THE OPERATION

It must be recognized that a certain amount of experience with the method is necessary before mastering the technic. So far as duration of operation is concerned, in my first seven or eight cases my time was generally fifty minutes. Since then it has become less, and for the last fifty I have rarely required over one-half hour to perform any variety of primary inguinal herniorrhaphy. Recurrents of course, may take somewhat longer.

It must be emphasized again that when the graft has been sutured into position it must be as taut as possible. When correctly bestowed it affords protection to the entire inguinal canal, and narrows the internal ring. In regard to this latter point, care must be taken not to narrow it too much lest later varicocele or testicular atrophy develop. The apex of the *v* in the graft should fit snugly into the muscle of the internal ring on its inferior aspect, and and cord should emerge smoothly but with a slightly altered direction, from the ring over the edge of the skin graft into the canal.

In preparing the bed for the graft it is essential to withdraw the cord and cremaster intact as far medially as possible, and to retract skin and loose areolar or fatty tissue at the medial extremity of the wound, so as to obtain a thoroughly good view of the area on the dorsum of the symphysis and the lower margin of the rectus abdominis. It is to this area that the graft will be sutured and it must be

adequately exposed. If attention is given to these points, the graft will give protection to the medial margin of the canal where a direct hernia is so prone to develop, and a stout reinforcement of the entire posterior wall of the canal will be effected.

In my experience the operation takes less time to perform than a fascial repair, and the finished immediate result appeals to me as being stronger than that presented by fascia. In very large cases a second layer of skin can be superimposed on the first.

There is never any difficulty in obtaining closure of the skin wound even after removal of the graft. There is always sufficient loose skin in the area to provide a large enough portion for use in repair.

The rationale of the procedure is sound. Skin and connective tissue are sutured to connective tissue.

There is not space in this communication to deal with the question as to feasibility of union between muscle and fascia or between conjoined tendon and Poupart's ligament. This has been thoroughly investigated, and the weight of evidence is overwhelming in demonstrating that any union which may take place is poor and of little value as a method of repair.<sup>44-48</sup> In the case of the skin graft, union should and does take place with great strength, because the underlying principle is sound. Care must be taken, however, to ensure that all fatty tissue is cleared from the area of operation, that there is no bleeding, and that any dead space between the graft and its bed is minimal in amount.

Finally, my impressions to date are that the method is superior to any other with which I am familiar, and that postoperative complications are fewer than when fascia is used. It is too early to give figures of recurrence or late postoperative morbidity, and it is again emphasized that this is but a preliminary report. Detailed analysis of the results will be presented in due course, and compared against those for fascial repairs, Bassini, and simple herniotomies, as performed in Woodend and Oldmill hospitals.

## SUMMARY

1. The place of fascia in the repair of hernias is considered, and its relative advantages and disadvantages assessed.

2. It is concluded that there is room for further improvement in hernial repair, and that it may be possible to evolve a more effective repair than that given by fascia.

3. The history and use of the "cutis" type of graft is described, and the essentials of the histology of these grafts indicated both for animals and for the human subject. On the basis of these findings it is suggested that there is no risk of later epidermoid or other cyst formation as a result of their use in hernial repair, and it is shown that in the cutis graft the epidermis is not completely removed.

4. An investigation into the use of whole skin grafts in preference to cutis grafts is described and the position to date given. The findings in both animals and in man in whom these grafts have been used to repair tissue defects are presented, and it is considered that the method is safe and promising of good results.

5. The technic of the operation in the case of indirect inguinal hernia is submitted and commented upon. The results in 137 cases of hernia repair, including several varieties, are presented.

6. Photographs are used to illustrate essential points in technic.

7. It is emphasized that this is a very preliminary report, and that later results will be published in the future.

Finally, I wish to express my thanks to Dr. Rae, D.P.H., Medical officer of Health for Aberdeen and Superintendent of these hospitals, for permission to perform and publish this work, to Dr. John Smith, D.Sc., F.R.C.P., Director of Aberdeen City Hospital, for facilities in his laboratory, and to Surgeon Lieutenant Anthony Smith, R.N.V.R. who took the photographs.

## REFERENCES

1. EDWARDS. *Brit. J. Surg.*, 31: 122, 1943.
2. KIRSCHNER. *Arch. f. klin. Chir.*, 92: 888-910, 1910.
3. GALLIE and LEMESURIER. *Canad. M.A. J.*, 11: 504-513, 1921.
4. MCCLOSKEY and LEHMAN. *Ann. Surg.*, 3: 610, 1940.
5. JOYCE. *J. A. M. A.*, 115: 971-977, 1940.
6. PAGE, MAX. *Proc. Roy. Soc. Med.*, 36: 185, 1943.
7. EDWARDS. *Brit. J. Surg.*, 31: 122, 1943.
8. JUDD. *J. Minnesota Med.*, 26: 56, 1908.
9. ERDMAN. *Ann. Surg.*, 77: 171, 1923.
10. BENDICK. *Ann. Surg.*, 106: 333, 1937.
11. BEEKMAN and SULLIVAN. *Surg., Gynec. & Obst.*, 68: 238, 1939.
12. CHURCHILL and MACNEIL. *Surg., Gynec. & Obst.*, 44: 483-488, 1927.
13. LAW. *Ann. Surg.*, 79: 250-254, 1924.
14. ROBITSHEK. *Minnesota Med.*, 8: 160-164, 1925.
15. KOONTZ. *Ann. Surg.*, 83: 523-526, 1926.
16. ROSENBLATT and MEYERS. *Surg., Gynec. & Obst.*, 47: 836-841, 1928.
17. JALIFER. *Lyon. chir.*, 17: 97-108, 1920.
18. CHRISTOPHE. *Arch. Franco-Belges de chir.*, 26: 13-56, 1923.
19. REHN. *München. med. Wchnschr.*, 1: 118, 1914.
20. LOEWE. *München. med. Wchnschr.*, 24: 1320, 1913.
21. UHLEIN. *Arch. Surg.*, 28: 118-130, 1939.
22. EITEL. *Deutsche Ztschr. f. Chir.*, 242: 86, 1934.
23. CANNADAY. *Am. J. Surg.*, 59: 409, 1943; *Ann. Surg.*, 115: 5, 775.
24. EITNER. *Med. Klin.*, 4: 93-95, 1920.
25. PEER and PADDOCK. *Arch. Surg.*, 34: 268-290, 1937.
26. PEER. *Jl. A. M. A.*, 115: 357-360, 1940.
27. GARRE. *Beitr. z. klin. Chir.*, 11: 524, 1894.
28. KAUFMAN. *Virchows Arch. f. path. Anat.*, 97: 236, 1884.
29. SCHWENINGER. *Chir. ann.*, 11: 642, 1884.
30. HESSE. *Beitr. z. klin. Chir.*, 80: 494, 1912.
31. PELS-LEUSDEN. *Deutsche med. Wchnschr.*, 31: 1340, 1905.
32. ZIMCHES. *Frankfurt Ztschr. f. Path.*, 42: 203, 1931.
33. PITZMAN. *Surg., Gynec. & Obst.*, 28: 329-331, 1919.
34. MILLER. *Surg., Gynec. & Obst.*, 29: 201, 1910.
35. QUAIN. *Surg., Gynec. & Obst.*, 30: 88-92, 1920.
36. WETHERELL. *Surg., Gynec. & Obst.*, 51: 133-134, 1930.
37. ANDREWS. *Med. Rec.*, October 28, 1899.
38. COOPER. *Anatomy and Surgical Treatment of Inguinal and Congenital Herniae*. London. 1804.
39. LONGACRE. Quoted by Edwards.<sup>1</sup>
40. MAINGOT. *Brit. M. J.*, 1: 777, 1941.
41. RANKIN. *Surg., Gynec. & Obs.*, 39: 92-93, 1924.
42. PETIT. *J. A. M. A.*, 95: 1497-1499, 1930.
43. LYLE. *Ann. Surg.*, 2: 145-148, 1928.
44. ROBERTS. *Ann. Surg.*, 81: 833-838, 1925.
45. ROSENBLATT and COOKSEY. *Ann. Surg.*, 86: 71-77, 1927.
46. ROSENBLATT and MEYERS. *Surg., Gynec. & Obst.*, 47: 836-841, 1928.
47. KOONTZ. *Surg., Gynec. & Obst.*, 42: 227, 1926.
48. SEELIG and CHOUKE. *Arch. Surg.*, 1: 553, 1923.



# OPERATIVE CURE OF INGUINAL HERNIA IN INFANCY AND CHILDHOOD\*

JEROME S. COLES, M.D.  
Fourth Division, Bellevue Hospital  
NEW YORK, NEW YORK

IN the young, the subject of inguinal hernia is predominantly concerned with the indirect type. Direct hernia is unusual in children, constituting definitely less than 1 per cent of all the inguinal hernias. To approach the problem of adequate surgical treatment of the common type, one must review the embryological development of a preformed indirect sac and the mechanical and anatomical peculiarities of the inguinal region in its relationship to such a preformed or congenitally indirect sac.

During the third month of fetal life, an evagination of peritoneum, the processus vaginalis, appears at the site of the future internal ring and emerges through the anterior abdominal wall. It enlarges slowly, from the fourth to the seventh month while the testis lies stationary in the iliac fossa close to the pelvic brim in the vicinity of the anterior abdominal wall. Descent of the testis through the inguinal canal into the scrotum occurs behind the advancing processus during the seventh, eighth and ninth months. Entering the scrotum, the testis and cord become enfolded by the processus which forms an incomplete investment. At no point are the testis and cord completely surrounded by the processus. At this stage, therefore, the tunica vaginalis, or that portion of the processus which lies in contact with the testis, has a cavity which is directly continuous with the cavity of the processus lying in the inguinal canal, which in turn is directly continuous with the general peritoneal cavity. This preformed sac remains patent at birth or soon after in 30 to 50 per cent of infants, according to estimates set forth by some writers.<sup>3,4,6</sup>

Normally obliteration of the processus vaginalis occurs from the internal ring to a short distance above the testis. Obliteration is apparently aided by the pressure of the muscular abdominal wall associated with both a loss of mesothelium and solidification, forming the funicular ligament. If the obliteration is not complete at birth, there are several possibilities: (1) If the entire processus, including the tunica, remains open, abdominal contents may enter it and form a hernia down to the lower pole of the testis, the so-called "congenital" hernia. (2) If the processus closes from a point just above the testis to a short distance below the internal ring, abdominal contents may enter it and form a hernia, the so-called "acquired" hernia. (3) If the processus narrows but does not obliterate at one or more points from just above the testis to a short distance below the internal ring, a hydrocele of the tunica vaginalis or of the cord, with or without an apparent hernia, the so-called "congenital" hydrocele, may develop.

Of course, in any of these three common types of inguinal hernia in children, should no abdominal contents enter the open processus and nothing occur to keep it open, the processus will be gradually obliterated in many cases.

Basically the inguinal canal is not weak. It is so powerfully constructed that if there is no patent processus vaginalis awaiting occupancy by an intra-abdominal tenant, it is impossible to produce an indirect inguinal hernia no matter how much force the child may exert in crying, straining or any other form of violent effort. During infancy, the internal ring is posterior to the external ring. The length of the inguinal

\* From the Children's Surgical Service of Bellevue Hospital, New York.

canal is therefore represented by the thickness of the abdominal wall. As the child grows, the internal ring is carried upward and outward, rendering the canal longer and more oblique. Then, however, during increased intra-abdominal pressure, the semi-sphincteric fibers of the internal oblique, which exert a lifting power, are called into play. This brings into action a corresponding amount of resistance over the inguinal canal.

Two anatomical conditions emphasize the congenital origin of the indirect inguinal hernia: (1) The vas deferens and blood vessels of the cord have a uniform relationship to the hernial sac. (2) An indirect inguinal hernia is more frequent on the right side. This is apparently related to the later descent of the right testis as compared to the left testis. The difference in time of descent is naturally compensated for by the usual final higher position of the right testis in the scrotum, thereby equalizing the time of obliteration of the right and the left processus vaginalis. However, if the difference in the process on both sides be enhanced, it would account for the greater frequency of indirect inguinal hernia on the right side.

In 1938, since it was clear to us that an inguinal hernia in a child is not due to any weakness or abnormality of the abdominal muscles or aponeuroses but is solely due to the presence of a preformed sac, we relinquished the common types of hernia repair and began to utilize an operative procedure which only isolates and ligatures the neck of the sac. In that manner we obviated the possible danger of testicular atrophy by: (1) not transplanting the cord with resulting compression of the delicate vessels of the cord, (2) not dislocating the testis from its natural bed, which practically always causes postoperative reactive swelling of the testis, and (3) not performing extensive dissection of the sac from the cord structures with resulting injury of the vessels of the cord. Furthermore, by eliminating an extensive dissection of the sac with plastic repair of the

inguinal canal, we did not disturb the anatomical relationships of normal muscular and aponeurotic structures so that attenuation of these structures with new weaknesses would result.

In attempting to imitate the natural process without disturbing the anatomical relationships of the inguinal structures, we do not believe that pulling the neck of the sac down through the external ring without opening the inguinal canal is a safe procedure. This type of operation has been done by many European surgeons, e.g., Kocher, Stiles and numerous contemporaries. We prefer to use an operation which is quite similar to that done by Philip Turner, Surgeon to Guys Hospital, 1920-1925. Reports of the results of two American surgeons<sup>1,2</sup> who used a similar operation have been incomplete.

The following is a description of our operation of choice: (1) An incision  $1\frac{1}{2}$  inches in length is made over the middle third of the line between the anterior superior iliac spine and the pubic tubercle. (2) The external oblique aponeurosis is incised in the direction of its fibers, but the external ring is left intact. (3) After Poupart's ligament is visualized, the fibers of the cremaster are separated, exposing the cord. (4) The sac and cord structures are picked up with a forceps in the lower angle of the wound. (5) The sac is dissected free of the cord structures at one level and transected. (6) The sac is then completely cleared proximally to its neck. (7) The neck of the sac is doubly transfixated and ligated, and the redundant sac between the level of transection and the ligature is excised. (8) The distal sac is permitted to drop back into the wound without further treatment. (9) The external oblique aponeurosis, Scarpa's fascia and skin are closed in layers.

#### RESULTS

The operation described, was performed upon 186 patients by all members of the attending and resident staff during the period from January, 1938, until May,

1944, inclusive. Of these patients, eighty-four had given incorrect addresses or had moved, and could not be contacted for follow-up observation. Among the remaining 102 patients, seventy-eight appeared for follow-up examination.

In the group of seventy-eight patients followed, eighty-eight operations for inguinal hernia were performed since ten were bilateral. The distribution of operations according to the age of the patient was as follows: (Table I):

TABLE I

Age of patient.....	2 mo.	3 mo.	6 mo.	8 mo.	1 yr.	2 yr.	3 yr.	4 yr.	5 yr.	6 yr.	7 yr.	8 yr.	9 yr.	10 yr.	11 yr.	12 yr.	13 yr.
No. of operations performed.....	2	2	1	1	3	6	4	7	8	7	11	10	8	6	3	8	1

In seventy-nine operations, silk was used and in nine catgut was used. Seven of the patients were females; all had unilateral hernias.

The following table (Table II) presents the relationship of the period of follow-up to the number of cases examined:

TABLE II

Period of follow-up.....	6 mo.	1 yr.	2 yr.	3 yr.	4 yr.	5 yr.	6 yr.
No. of cases.....	5	14	22	10	12	17	8

There was one recurrence noted in the group. It occurred on one side of a bilateral hernia operation performed on a three months' old infant. The recurrence was found during the first six months following operation.

No case of testicular atrophy was noted in the series. In two cases, however, the testis on the side of the previous hernia was smaller than the other testis.

## COMMENT

It is our belief that the one case of recurrence was not related to the type of operation used, but rather to its faulty technical execution. The sac was very thin, large, and in its scrotal portion,

filled with bowel. During the operation, the sac was torn posteriorly proximal to its neck. The operator, at the time, thought that ligation of the sac might have been insecure. At the subsequent operation for recurrence, the sac was noted to contain a loop of bowel attached to the posterior wall as in a "sliding" type of hernia.

In the two cases in which the testis was smaller on the side of the hernia following repair of the latter, the preoperative note in the hospital charts did not indicate the

size of the testes. However, in the group, three other cases were noted in which the testis on the side opposite to the hernia was subsequently found to be smaller than the other testis. Since no case of atrophy of the testis was noted on the homolateral side, these cases of inequality of the testes are of no significance.

Included in this series are several cases of hydrocele of the cord or of hydrocele of the tunica vaginalis, associated with or without a hernia upon clinical examination. (Figs. 1 to 6.)

When these patients remained in bed for several days or longer before operation, we observed that the hydrocele diminished in size or disappeared entirely. It is evident, therefore, that the hydrocele is produced only by the passage of fluid from the peritoneal cavity through a stenosed portion of the processus vaginalis into a wide patent portion or into the wide patent tunica vaginalis. Because of the stenosis, the fluid tends to remain in the wide portion as long as the patient assumes the erect position permitting the force of gravity to act. The accumulation of the fluid is further enhanced by the presence of a hernia proximal to the narrowed portion of the processus.

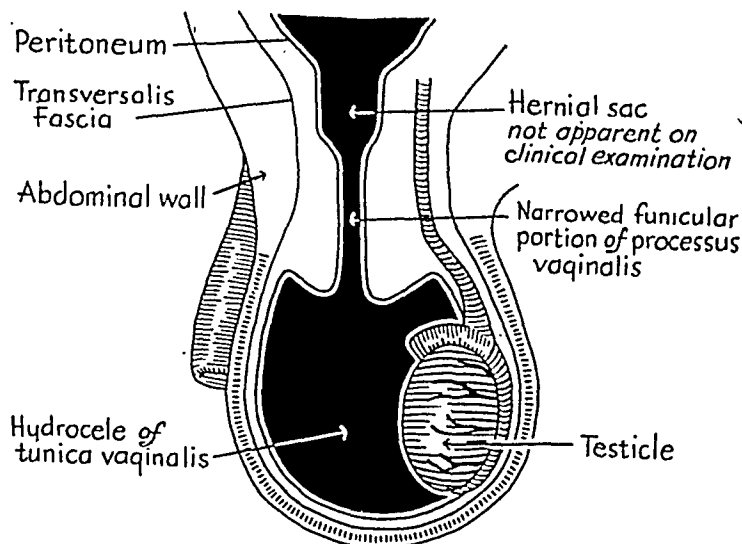


FIG. 1.

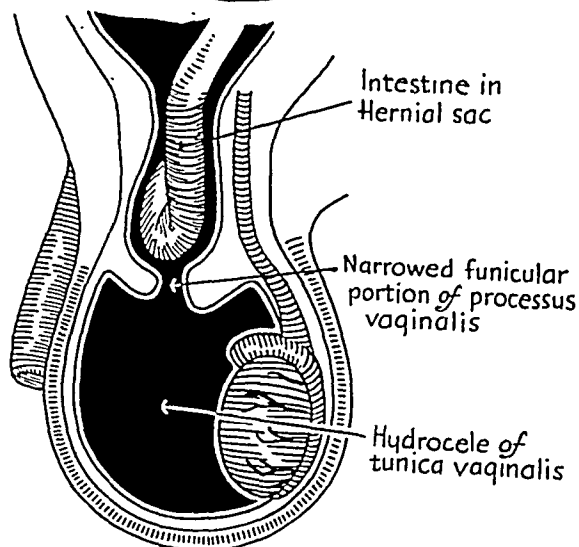


FIG. 2.

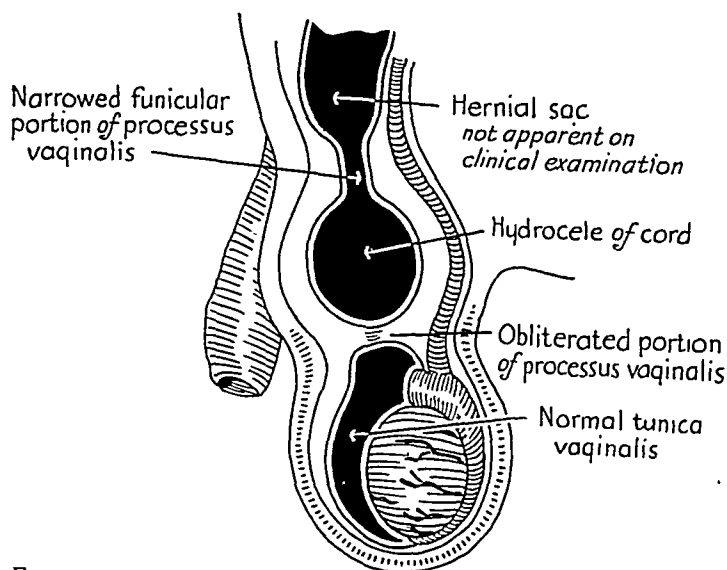


FIG. 3.

FIG. 1. Hydrocele of tunica vaginalis without an apparent hernia.  
 FIG. 2. Hydrocele of tunica vaginalis with an apparent hernia.  
 FIG. 3. Hydrocele of cord without an apparent hernia.



FIG. 4.

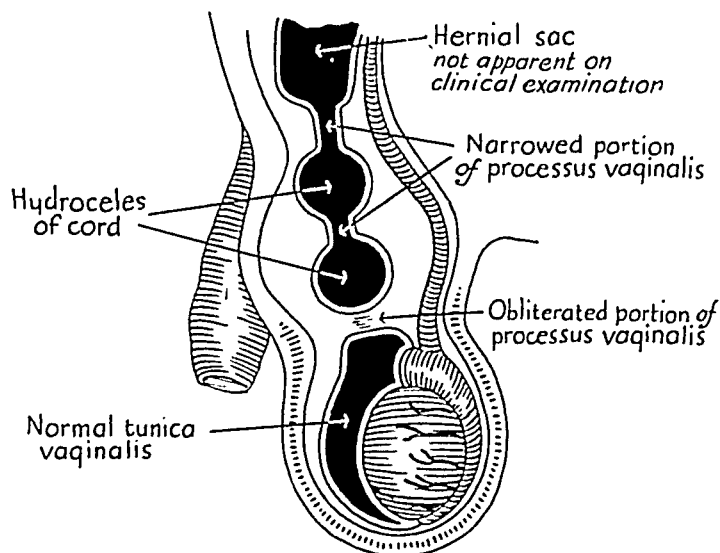


FIG. 5.

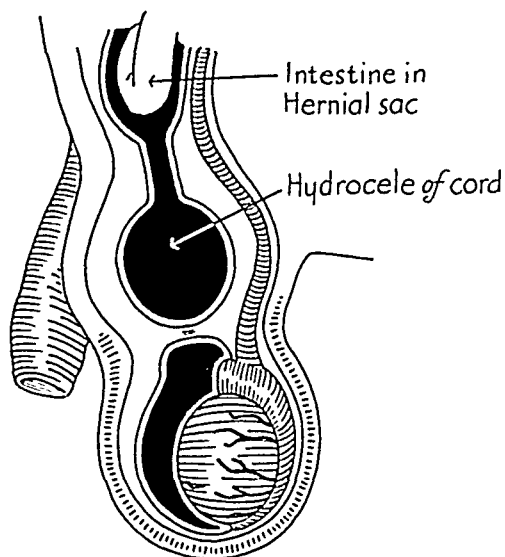


FIG. 6.

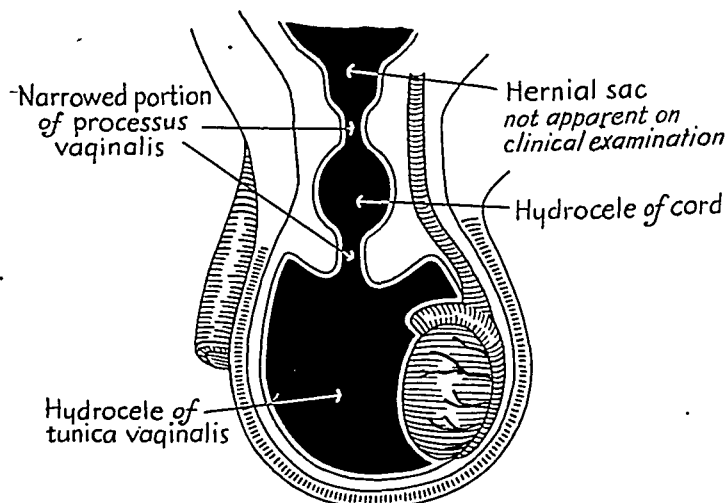


FIG. 4. Bilocular hydrocele of cord without an apparent hernia.

FIG. 5. Hydrocele of cord with an apparent hernia.

FIG. 6. Combination hydrocele of cord and tunica vaginalis without an apparent hernia.

It is possible, therefore, that in a child, there is no such thing as a pure hydrocele in which there is actual secretion of fluid by the lining cells of the processus vaginalis or tunica vaginalis. If this is true, a simple ligation of the hernial sac at its neck is enough to cure all hydroceles in children. In all those cases, in which this was done, the hydrocele disappeared. Sometimes it took several weeks or longer postoperatively for the fluid to be entirely absorbed.

We also noted, in dealing with these cases, that the largest hydrocele which appeared clinically as a typical hydrocele of the tunica vaginalis, at operation was usually found to be associated with a small hernial sac just beginning to appear at the internal ring. Furthermore, at operation, in some cases the stenosed portion of the processus could be demonstrated by passing a probe through it while in others it could not, appearing completely occluded. Yet, since simple ligation of the sac at the internal ring cured all these patients, the processus must have been patent but narrowed so much that it would not admit the passage of a probe.

Although we are convinced that ligation of the hernial sac cures all hydroceles in children, practically speaking, since some of these patients take some time postoperatively to absorb the fluid completely, it might be advisable to empty the hydrocele also at the time of operation. This can be done in either of two ways. If the hydrocele lies within the incision, it can be emptied by puncturing it with the scalpel. This situation will be found with a

hydrocele of the cord. If the hydrocele lies below the incision, it can be emptied by needle aspiration through the scrotum immediately after the operation is completed. This situation will be found with a hydrocele of the tunica vaginalis.

#### SUMMARY

1. A follow-up study of eighty-eight cases of indirect inguinal hernia, in which seventy-eight patients were treated on the Children's Surgical Service of Bellevue Hospital by simple isolation and ligation of the neck of the sac, is presented.
2. The follow-up comprises a period from six months to six years.
3. One recurrence is noted within six months after operation, and is apparently not related to the type of operation performed.
4. No case of testicular atrophy is demonstrated.
5. A new method for the surgical treatment of hydrocele in the young is described.

#### REFERENCES

1. COE, H. E. *West J. Surg.*, 40: 248-251, 1932.
2. DOUGHTY, ROGER G. *South. M. J.*, 21: 1007-1008, 1928.
3. DUCKETT, J. W. *Dallas M. J.*, 27: 118-119, 1941.
4. ARNOLD, E. *Human Embryology and Morphology*. 4th ed., London, 1921.
5. KOCHER, THEODORE. *Textbook of Operative Surgery*. Vol. II, MacMillan Co., New York, 1911.
6. SEEGAR, STANLEY J. *West. Surg. Ass. Tr.*, 48: 293-315, 1939.
7. STILES, HAROLD J. *Surg., Gynec. & Obst.*, 27: 371-384, 1905.
8. TURNER, PHILIP. *Guys Hosp. Rep.*, 79: 234-240, 1929.



# PRIMARY MALIGNANT DISEASE OF THE SMALL INTESTINE\*

THOMAS A. SHALLOW, M.D.,  
Attending Surgeon,  
Jefferson Medical College Hospital

SHERMAN A. EGER, M.D.  
Assistant Surgeon,  
Jefferson Medical College Hospital

AND

JAMES B. CARTY, M.D.  
Fellow in Surgery, Jefferson Medical College Hospital  
PHILADELPHIA, PENNSYLVANIA

**P**PRIMARY malignancy of the small intestine is a challenge to modern surgery because of its rarity, diffi-

## CASE REPORT

This case is that of a primary adenocarcinoma of the mid-jejunum producing a contact,



FIG. 1. A, roentgenogram of small intestine following barium meal; showing fistula between mid-jejunum and terminal ileum. B, roentgenogram following barium enema showing the opaque material ascending from the terminal ileum through the fistula to the jejunum.

culty of early diagnosis, extensive technic required, high operative mortality and grave prognosis. For this reason a study was made of thirty-eight consecutive cases of histologically proven primary malignancy of the small bowel encountered in the Jefferson Medical College Hospital. One unusual case is described in detail:

fistulous communication with the terminal ileum, requiring extensive surgery which was successfully performed.

A sixty-nine year old white female was admitted to the Jefferson Medical College Hospital on May 29, 1940, complaining of recurrent attacks of epigastric pain, vomiting and diarrhea during the past two years, accompanied by a gradual loss of thirty pounds

\* From the Samuel D. Gross Surgical Division of the Jefferson Medical College Hospital. Presented before the Philadelphia Academy of Surgery, November, 1942.

in weight. Increasing in frequency, these attacks finally occurred once or twice a week and lasted about two hours. The stools had been a putty color but never contained gross blood or mucous. A gastrointestinal x-ray study, February, 1938, showed only hypermotility of the small intestine. Past history and family history were negative for malignancy.

Positive findings were limited to the abdomen where there was a hard, moveable, orange-sized mass to the right of the umbilicus. There was no tenderness, distention or ascites.

The blood count showed hemoglobin 48 per cent, red cells 2,500,000, color index .98 and white cells 5,600. Repeated urine examinations were normal. The non-protein nitrogen of the blood was 23 mg. The bromsulfalein test revealed all dye removed from the blood serum in thirty minutes. The Van den Bergh reaction was negative direct. A quantitative Van den Bergh and icteris index were 0.6 mg. and 9 units, respectively. Plasma prothrombin time was 50 per cent of average normal. Stool examination was negative for gross and occult blood. Electrocardiographic study was normal.

Roentgenographic examination following a barium meal revealed a fistulous communication between the mid-jejunum and the terminal ileum. (Fig. 1A.) A barium enema revealed no abnormality in the large bowel but showed a considerable amount of opaque material entering the small intestine, passing from the terminal ileum through a fistula into the jejunum. (Fig. 1B.)

Preoperative treatment extended over a seven-day period and consisted of a high vitamin, high caloric, low residue diet, whole blood transfusions, vitamin K, bile salts and intravenous glucose in saline solution.

On May 31, 1940, under spinal anesthesia, the abdomen was opened through a mid-right rectus incision. A tumor was found involving the mid-jejunum and terminal ileum about 15 cm. from the ileocecal valve with the area of contact about 4 cm. in length in a side-to-side manner. (Fig. 2A.) This mass with involved bowel and regional mesentery was resected (Fig. 2B) followed by an end-to-end jejunojejunostomy, end-to-side ileo-ascending colostomy and inversion of the stump of the terminal ileum into the cecum. (Fig. 2C.) A temporary ileostomy was made using a soft rubber catheter. The abdomen was closed without drainage. The total operating time was two hours and fifteen minutes.

Pathologically the specimen consisted of two pieces of small intestine, jejunum and ileum, joined together in a side-to-side manner with

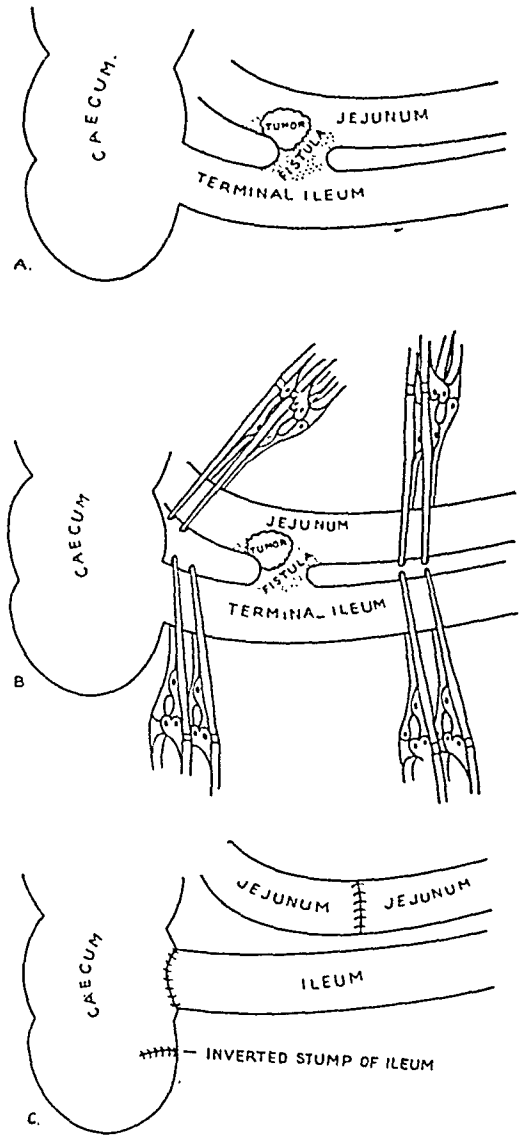
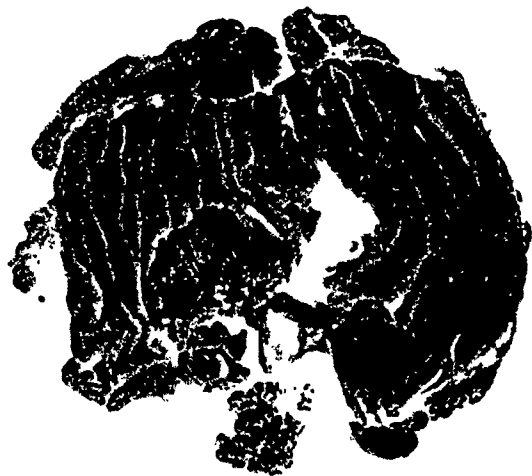


FIG. 2. A, diagram showing tumor of mid-jejunum with contact carcinoma and fistula to terminal ileum. B, diagram showing clamps in place prior to bowel resection. C, diagram showing intestinal anastomoses as well as inversion of terminal ileal stump completed.

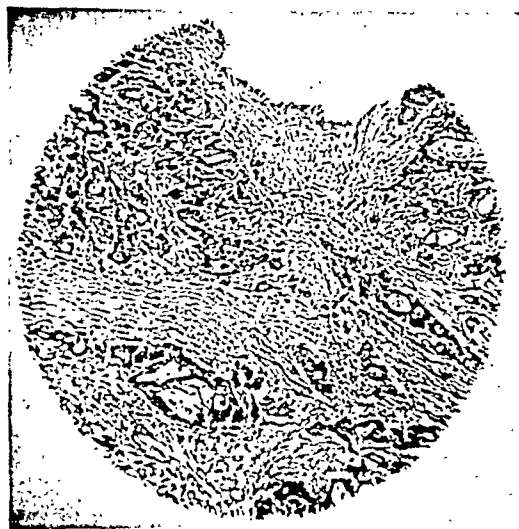
an ostium 2 cm. in diameter connecting them. Both segments were 10 cm. in length. On the jejunal side of the ostium, extending along the mucosa, was a large cauliflower mass 3 cm. in diameter. (Fig. 3A.) In histological section (Fig. 3B) the normal mucosa was suddenly interrupted by a change in character of both the glands and the cells composing them. The glands were more numerous, arranged in disorderly fashion and infiltrated the sub-

mucous tissue. The cells had lost their secretory power and contained hyperchromatic nuclei and many mitoses.

250 cc. of citrated blood, intravenous fluids were continued for thirteen days maintaining a daily urine output of 1,500 cc. The ileostomy



A



B

FIG. 3. A, opened specimen showing tumor of jejunum arising from margin of ostium. B, microphotograph of tumor shown in Figure 3A; 100 X.



A



B

FIG. 4. A, postoperative roentgenogram one and one-half hours after barium meal. The outline of the intestine shows no distention and a normal functioning jejunojejunostomy. B, postoperative roentgenogram four and one-half hours after barium meal. The outline of the terminal ileum and colon shows that the ileo-ascending colostomy is functioning.

The diagnosis was primary adenocarcinoma of the jejunum.

Postoperatively in addition to 500 cc. of .8 per cent sulfanilamide solution parenterally daily for five days and two transfusions of

tube was withdrawn on the eighth day. Following a satisfactory convalescence, the patient was discharged from the hospital on the thirty-third postoperative day, in excellent condition.

TABLE I  
FREQUENCY OF INTESTINAL MALIGNANCY AMONG GENERAL AUTOPSIES COLLECTED FROM LITERATURE

Author	Source	Year	No. of Autopsies	Large Intestines		Small Intestines	
				No.	Per Cent	No.	Per Cent
Leichtenstern <sup>14</sup> .....	Vienna Gen. Hospital	1858	34,523	770	2.23	33	.095
Maydi <sup>17</sup> .....	Vienna Gen. Hospital	1870	20,480	100	.488	6	.029
Nothnagel <sup>22</sup> .....	Vienna Gen. Hospital	1881	21,358	243	1.13	11	.051
Muller <sup>20</sup> .....	Path. Inst. of Berne	1893					
		1886	5,621	41	.729	9	.160
Heiman <sup>10</sup> .....	Hospitals of Prussia	1891					
		1895	20,054	1,708	8.50	20	.099
		1896					
Meyer and Rosenberg <sup>19</sup> ....	Cook Co. Hosp. Mich'l. Reese Hospital	1931	10,876	569	5.23	10	.091
Nickerson and Williams <sup>21</sup> ...	Boston City Hospital	1937	11,206	343	3.05	10	.089
Christofferson and Jacobs <sup>4</sup> ..	Cook Co. Hospital	1929	10,309	163	1.50	5	.048
		1933					
Bowe and Neely <sup>26</sup> .....	Bryan Mem. Lincoln Gen.	1928	1,191	181	15.1	8	.671
		1937					
Medinger <sup>18</sup> .....	New Eng. Deac. Palmer Mem.	1927	1,456	918	63.04	22	1.51
		1939					
Total.....			137,174	5,034	3.66	134	.098

A roentgenographic study of the small intestine and colon, three and one-half months after operation, revealed no abnormality.

(Figs. 4A and B.) At the present time, four years after operation, the patient is entirely symptom free.

TABLE II  
FREQUENCY OF SMALL INTESTINAL MALIGNANCY AMONG GENERAL INTESTINAL MALIGNANCY—UPPER TABLE CARCINOMA, LOWER TABLE SARCOMA

Author	Intestinal Carcinoma	Small Intestinal Carcinoma	
		No.	Per Cent
Jefferson <sup>12</sup> .....	4,177	130	3.1
Meyer and Rosenberg <sup>19</sup> ...	569	10	1.7
Aaron <sup>1</sup> .....	343	17	4.9
Ackman <sup>2</sup> .....	600	7	1.0
Hinz <sup>11</sup> .....	584	18	3.08
Total.....	6,273	182	2.9

Author	Intestinal Sarcoma	Small Intestinal Sarcoma	
		No.	Per Cent
Crowther <sup>5</sup> .....	191	117	61.2
Ullman and Abeshouse <sup>31</sup> ..	126	78	61.9
Staemmler <sup>28</sup> .....	394	218	55.3
Liu <sup>16</sup> .....	12	9	75.0
Weeden <sup>33</sup> .....	12	10	83.3
Graves <sup>9</sup> .....	249	166	67.3
Total.....	984	598	60.7

#### INCIDENCE

Primary small intestinal malignancy occurs in 0.1 per cent of all general autopsies while that of the large is found in 3.6 per cent, or thirty-six times as frequent. (Table I.) Among general intestinal carcinoma and sarcoma, the small bowel is involved in 3 and 60 per cent, respectively. (Table II.) Table III shows that malignancy in general occurs with about equal frequency in each of the three divisions of the small intestine, that carcinoma is found twice as often as sarcoma and that the ileum ranks lowest for carcinoma but highest for sarcoma. Of 305 collected primary duodenal carcinomas, Eger<sup>7</sup> found 62 per cent in the second portion, 24 per cent in the first, 12 per cent in the third portion and 2 per cent involved the entire duodenum. Small intestinal carcinoids comprise 0.02 per cent of autopsy and surgical

specimens, 8.3 per cent of all small intestinal neoplasms and occur chiefly in the ileum but occasionally in the jejunum and duodenum (Ariel<sup>3</sup>).

contradistinction to carcinoma. Carcinoids are usually small, firm, submucosal yellow nodules which rarely produce obstruction, grow slowly and metastasize in 25 per

TABLE III

INCIDENCE AND DISTRIBUTION OF CARCINOMA AND SARCOMA AMONG PRIMARY SMALL INTESTINAL MALIGNANCIES

Author	Source	Years	No. of Cases	Duodenum				Jejunum				Ileum			
				Carcinoma		Sarcoma		Carcinoma		Sarcoma		Carcinoma		Sarcoma	
				No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent
Raiford <sup>25</sup> ...	Johns Hopkins Hosp.	Up to 1931	35	7	20.0	1	2.9	4	11.4	1	2.9	3	8.5	19	54.3
Stein <sup>29</sup> ....	Edward Hines Jr. Hospital	1931-1936	7	2	28.5	0	....	2	28.5	1	14.5	2	28.5	0	....
Doub and Jones. <sup>6</sup>	Henry Ford Hospital	Up to 1936	13	9	69.3	1	7.7	3	23.0	0	....	0	....	0	....
Rowe and Neely. <sup>26</sup>	Lancaster Co. Lab. Bryan Memorial Hosp. Lincoln Gen. Hosp. Lincoln Clinic	1928-1937	8	1	12.5	0	....	5	62.5	0	....	0	....	2	25.0
Ragins and Shively. <sup>21</sup>	Cook Count Hospital	1929-1938	14	3	21.5	1	7.1	7	50.0	0	....	1	7.1	2	14.3
Goldberg <sup>8</sup> ..	Presbyterian Hosp., Newark, N.J.	1930-1938	7	3	42.8	0	....	1	14.4	3	42.8	0	....	0	....
Medinger. <sup>18</sup>	Path. Lab. of New England Deaconess Hosp. Palmer Memorial Hosp.	Up to 1939	18	3	27.8	0	....	8	44.4	0	....	2	11.1	5	16.7
Weber and Kirkland <sup>32</sup>	Mayo Clinic	Up to 1942	84	23	27.4	2	2.4	31	36.9	2	2.4	21	25.0	5	5.9
Swenson <sup>30</sup> ..	Presbyterian Hosp. New York, N.Y.	Up to 1943	45	8	17.8	7	15.5	9	20.0	8	17.8	5	11.1	8	17.8
Authors' series.	Jefferson Hospital	Up to 1943	38*	14	37.8	0	....	5	13.5	6	13.5	4	10.8	9	24.4
Total.....			269	73	27.2	12	4.5	75	27.8	21	7.8	38	14.1	50	18.6

\* Two cases of malignant leiomyoma of the jejunum previously reported by Klopp and Crawford,<sup>13</sup> and 1 duodenal carcinoma previously reported by Lieber, Stewart and Morgan.<sup>15</sup>

#### PATHOLOGY

Primary carcinomas of the small intestine are divided by their gross morphology into three types which in order of frequency are the stenosing (Figs. 5A and B), the infiltrating or ulcerative and the polypoid. (Fig. 6.) Primary sarcoma usually extends toward the mesentery without producing obstruction (exception observed in Figs. 7A and B) or hemorrhage, in

cent chiefly to the regional nodes and only occasionally to the liver (Ariel<sup>3</sup>).

Thirty-one of the thirty-eight cases of primary small intestinal malignancy in this series had evidence of extension or metastasis most frequently to the regional nodes and liver. (Table IV.) Of the seven duodenal carcinomas, there was no metastasis in one, regional node involvement in one and widespread metastasis in five. Parsons and Mullins<sup>23</sup> believe that am-

pullary malignancies first extend along the common duct and into the pancreas. In our group of seven ampullary lesions, all of

the onset of symptoms was usually insidious, although occasionally it was sudden with a perforation, a severe hemorrhage

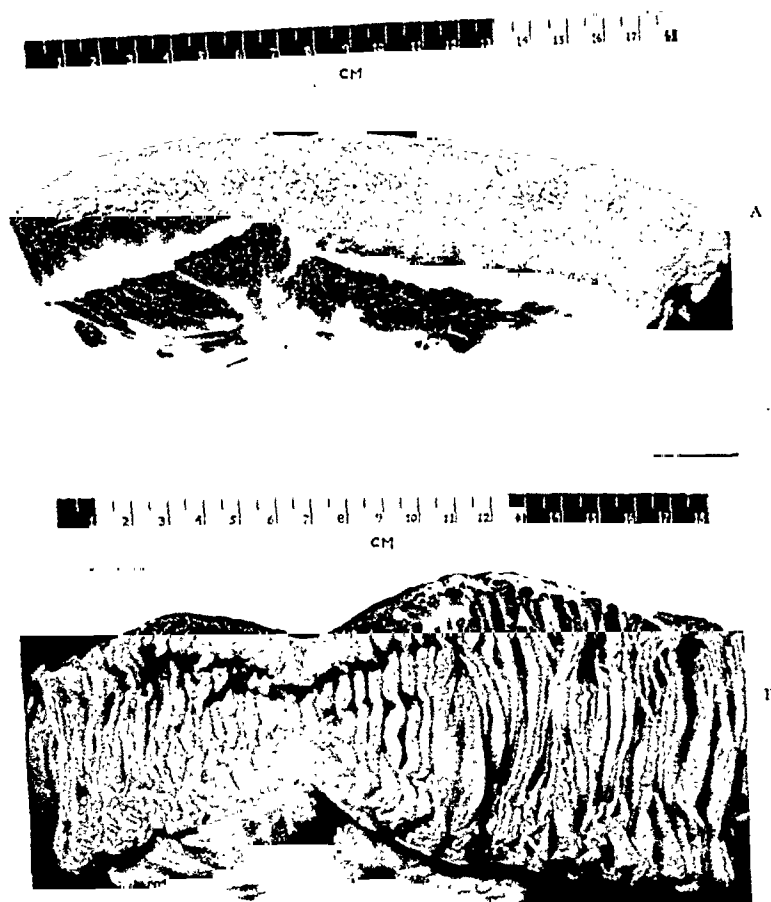


FIG. 5. A, stenosing adenocarcinoma of the jejunum. B, opened specimen of stenosing adenocarcinoma of the jejunum.

which were carcinoma, five showed metastasis, but the pancreas was only involved in one. Of the twenty-four jejunal and ileal malignancies, four were without evidence of extension or metastasis, nine involved only the regional nodes and eleven had widespread metastasis. There were no malignant carcinoids.

#### DIAGNOSIS

The early diagnosis of primary malignancy of the small intestine is dependent upon careful evaluation of the history, physical, laboratory, and roentgen ray findings. Among these thirty-eight cases

or an acute intestinal obstruction (Figs. 7A and 7B); the duration of symptoms varied from five days to three years, with an average of seven months. Lesions of the ampullary portion produced biliary obstruction before intestinal obstruction in all cases; occasional intermittency and variation in intensity of the jaundice may result from sloughing of the tumor, increased intrabiliary tension forcing bile through the point of constriction and the subsidence of papillary edema. Over 75 per cent of the small intestinal neoplasms in this series were palpable, usually fixed in the duodenum and mobile in the



jejunum and ileum. Laboratory studies not only aided in the diagnosis, but also in determining the severity of the disease

Vater, two carcinomas and one sarcoma of the jejunum and two carcinomas and two sarcomas of the ileum, even though the

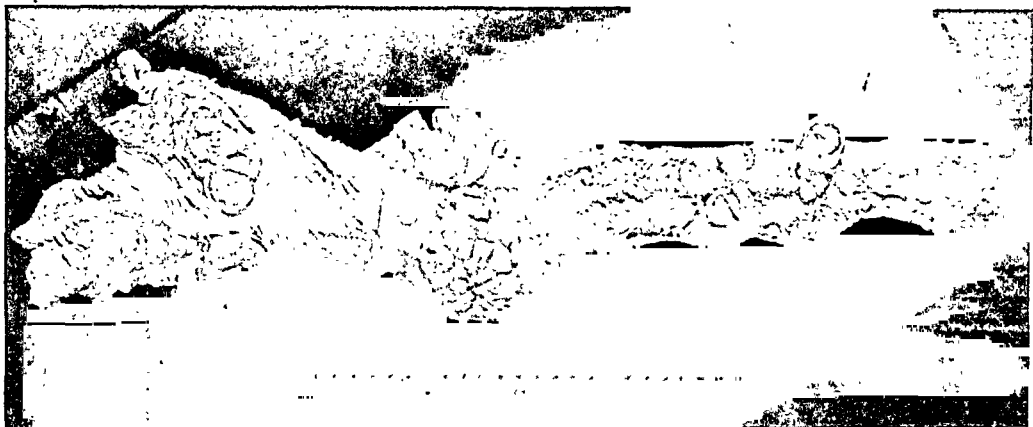


FIG. 6. Multiple polypi of ileum having undergone malignant change.

and served as a guide in the pre- and post-operative management. Of the twenty-nine cases with roentgenographic gastrointestinal studies, the lesion was demonstrated in seventeen and suggested in another; the examination was unsatisfactory in two duodenal carcinomas and one extensive sarcoma of the ileum because of vomiting. Eight neoplasms not demonstrated following a complete gastrointestinal examination were one carcinoma of the ampulla of

duration of symptoms for this group averaged fourteen months.

TREATMENT AND RESULTS

In addition to decompression of the gastrointestinal tract, it is essential that these patients be improved medically to a maximum degree before operation and supported after operation by correcting any fluid and electrolyte imbalance,

TABLE IV  
INCIDENCE AND SITE OF METASTASES

	No. of Cases		Without Metastases		Regional Nodes		Liver	Pancreas	Retroperitoneal Nodes		Peritoneum	Lung	Adrenals	Kidney	Cecum	Transverse Colon and Mesocolon	Gallbladder	Ovary	Brain	Lumbar Vertebra	Spleen	Ribs
Duodenum—Carcinoma.....	7	1	6	5	3	..	2	1	..	..	..	..	..	..	..	..	1	..	..	..	..	..
Ampulla of Vater—Carcinoma.....	7	2	3	4	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Jejunum—Carcinoma.....	5	3	2	1	..	..	..	..	..	..	..	..	..	..	..	1	..	1	..	..	..	..
Jejunum—Sarcoma.....	6	..	6	1	..	..	..	..	..	..	..	..	..	1	..	1	..	..	1	..	..	..
Ileum—Carcinoma.....	5	..	5	1	..	2	1	1	1	1	1	1	1	1	1	..	..	..	1	1	..	1
Ileum—Sarcoma.....	8	1	7	..	..	1	..	..	1	..	..	1	1	..	1	..	..	..	..	..	1	..
Total.....	38	7	29	12	4	3	3	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1

anemia, vitamin and plasma protein deficiency and impaired function of the heart, liver and kidneys.

continuity of the bowel is the treatment of choice.

In this series a variety of surgical pro-



FIG. 7. A, specimen of lymphosarcoma of the jejunum with intussusception producing obstruction. B, opening specimen of lymphosarcoma of the jejunum with intussusception.

The type of operative procedure depends upon the condition of the patient, the location and extent of the growth and the presence or absence of complications as jaundice or metastasis. Early and adequate resection of the growth and regional mesentery with re-establishment of the

cedures was performed. (Table v.) The only duodenal malignancy resected was a carcinoma in the third portion. The third and fourth portions were resected followed by an antecolic side-to-side duodeno-jejunojejunostomy anastomosing the second portion of the duodenum, just distal to the

ampulla of Vater, to the jejunum 10 inches from the ligament of Treitz. The patient was well ten months later (Shallow, Eger, Carty<sup>27</sup>).

in two, without metastasis, had they survived the first stage.

All the jejunal lesions found at operation were resected followed by primary anasto-

TABLE V  
OPERATIVE PROCEDURES EMPLOYED IN AUTHORS' SERIES

	Duodenum Carcinoma	Ampulla of Vater Carcinoma	Jejunum		Ileum		Total
			Carcinoma	Sarcoma	Carcinoma	Sarcoma	
Resection; side-to-side duodenojejunosomy.....	1	..	..	..	..	..	1
T-tube drainage of common duct.....	1	..	..	..	..	..	1
Gastro-enterostomy.....	1	..	..	..	..	..	1
Cholecystogastrostomy.....	..	3	..	..	..	..	3
Gastro-enterostomy, cholecytojejunosomy.....	1	..	..	..	..	..	1
Cholecysto-enterostomy, Y-type; gastro-enterostomy.....	..	1	..	..	..	..	1
Cholecystogastrostomy, ligation of common bile duct, gastro-enterostomy, entero-enterostomy.....	..	1	..	..	..	..	1
Resection; end-to-end anastomosis.....	..	..	2	2	1	1	6
Resection; three separate end-to-end anastomoses.....	..	..	..	..	..	1	1
Resection; end-to-end anastomosis with proximal enterostomy.....	..	..	..	..	..	1	1
Resection; side-to-side anastomosis.....	..	..	2	..	..	..	2
Resection of jejunum and portion of transverse colon, end-to-end anastomoses of each.....	..	..	..	1	..	..	1
Resection of portion of jejunum followed by end-to-end anastomosis; resection of terminal ileum followed by end-to-side ileo-ascending colostomy.....	..	..	1	..	..	..	1
Resection; end-to-side anastomosis of ileum to splenic flexure of colon.....	..	..	..	..	1	..	1
Resection; ileotransverse colostomy, proximal ileostomy.....	..	..	..	..	..	1	1
Exteriorization of tumor.....	..	..	..	..	..	1	1
Exploratory laparotomy.....	..	..	..	..	1	2	3
Total No. of operations.....	4	5	5	3	3	7	27

In the ampullary group, the bile was redirected to the gastrointestinal tract in all cases, but resection was contemplated

moses. One, because of a contact carcinomatous fistula, also required a resection of the terminal ileum followed by an

end-to-side anastomosis of the ileum and ascending colon (see case report). Another produced contact sarcoma to the transverse colon which was also successfully resected and anastomosed primarily. The patient is well twelve years later. Another died of sarcomatous metastasis after fifteen years (Klopp and Crawford<sup>13</sup>).

TABLE VI  
OPERATIVE MORTALITY AMONG TWENTY-SEVEN PRIMARY MALIGNANCIES OF THE SMALL INTESTINE

Location and Type of Neoplasm	No. of Operations	Post-operative Mortality	Percentage Mortality
Duodenum Carcinoma...	4	2	50
Ampulla of Vater Carcinoma.....	5	3	60
Jejunum			
Carcinoma.....	5	1	20
Sarcoma.....	3	1	33
Ileum			
Carcinoma.....	3	1	33
Sarcoma.....	7	4	57
Total.....	27	12	44

In the ileum, six malignant tumors were resected and primary anastomoses were performed, another was merely exteriorized and three, not resectable, were administered roentgen therapy. Of the resected

group, one lymphosarcoma is well seven years later, and the remaining two, which survived the operation, are lost to follow-up.

The results of surgery compare very unfavorably with those for malignancy of the large intestine. Since small intestinal malignancy metastasizes early and its diagnosis is difficult, it is usually beyond the point of curative resectability when operation is performed. The prognosis of sarcoma seems better than carcinoma. Primary malignancy is most favorable in the jejunum and least in the duodenum. Of these thirty-eight cases, twenty-seven were treated surgically with an operative mortality of 44 per cent. (Table VI.) Four are living and well twelve, seven, and four years, and ten months, respectively, after operation; four others lived fifteen, four, three and one year respectively; sixteen survived six months or less; three have been lost to follow up and eleven expired without surgery. (Table VII.) The most common causes of death were metastasis and circulatory failure. (Table VIII.)

SUMMARY AND CONCLUSIONS

Thirty-eight consecutive and verified cases of primary malignancy of the small intestine are reviewed and an unusual case of jejunal carcinoma, producing a contact

TABLE VII  
END RESULTS OF THIRTY-EIGHT PRIMARY MALIGNANCIES OF THE SMALL INTESTINE

Location and Type of Neoplasm	No. of Cases	Expired without Operation	Duration of Life Following Operation									
			1 Week	1 Mo.	3 Mo.	6 Mo.	1 Yr.	3 Yr.	4 Yr.	15 Yr.	Living and Well	Lost to Follow-up
Duodenum Carcinoma												
Supra-amp.....	3	2	..	1								
Peri-amp.....	3	1	1	1								
Infra-amp.....	1	..	..	..	..	..	..	..	..			
Ampulla of Vater Carcinoma.	7	2	3	..	..	..	1	..	..	..	1 (10 mo.)	
Jejunum Carcinoma.....	5	..	1	..	..	1	..	1	1	..	1 (4 yr.)	1
Jejunum Sarcoma.....	6	3	1	..	..	..	..	..	..	1	1 (12 yr.)	
Ileum Carcinoma.....	5	2	..	1	..	..	..	..	..	..	1 (7 yr.)	
Ileum Sarcoma.....	8	1	3	1	1	1	..	..	..	..		2
Total.....	38	11	9	4	1	2	1	1	1	1	4	3

TABLE VIII  
CAUSES OF DEATH IN THIRTY-FOUR CASES

Causes of Death	With Operation	Without Operation
Metastasis.....	8	8
Circulatory failure.....	5	
Acute intestinal obstruction due to metastasis.....	2	
Pneumonia.....	2	
Peritonitis.....	2	
Hepatorenal insufficiency.....	1	
Gastrointestinal hemorrhage.....	..	1
Liver and pancreatic necrosis.....	..	1
Diabetic acidosis.....	..	1
Lost to follow-up.....	3	
Total.....	23	11

fistula to the terminal ileum, is described in detail.

The incidence of small intestinal malignancy among general autopsies is found to be .1 per cent or about 36 times less frequent than large intestinal malignancy. Three per cent of intestinal carcinomas and 60 per cent of intestinal sarcomas occur in the small intestine. Carcinoma is twice as common as sarcoma. Malignancy in general occurs with about equal frequency in all three divisions of the small intestine; however, the ileum ranks lowest for carcinoma but highest for sarcoma.

Careful roentgenographic study seems to be the best aid to diagnosis of these lesions at the present time.

Although the treatment of choice is early and adequate resection of the growth and regional mesentery with re-establishment of the continuity of the bowel, the type of operative procedure depends upon the condition of the patient, the location and extent of the growth and the presence or absence of complications as jaundice or metastasis.

The operative mortality, 44 per cent for the entire series, is highest in the duodenal group and lowest in the jejunal group.

The results of surgery in small intestinal malignancy compare unfavorably with those for malignancy of the large intestine.

## REFERENCES

1. AARON, C. D. Carcinoma of the duodenum. *Philadelphia Med. J.*, 3: 280-283, 1899.
2. ACKMAN, F. D.: Carcinoma of small intestine. *Canad. M. A. J.*, 32: 634-639, 1935.
3. ARIEL, I. M. Argentaffin (carcinoid) tumors of the small intestine. *Arch. Path.*, 27: 25-52, 1939.
4. CHRISTOFFERSON, E. A. and JACOBS, M. B. Primary adenocarcinoma of jejunum with perforation, case with some clinicopathologic notations. *J. A. M. A.*, 112: 1576-1579, 1939.
5. CROWTHER, C. Studio dei sarcomi primitivi dell'intestino tenue con contributo di tre casi originali. *Clin. chir. Milano*, 21: 2107-2144, 1913.
6. DOUB, H. P. and JONES, H. C. The Roentgenologic diagnosis of tumors of the small bowel. *Am. J. Digest Dis.*, 8: 149-154, 1941.
7. EGER, S. A. Primary malignant diseases of the duodenum. *Arch. Surg.*, 27: 1087-1108, 1933.
8. GOLDBERG, S. A. Unusual neoplasms of small intestines. *Am. J. Clin. Path.*, 9: 516-528, 1939.
9. GRAVES, S. Primary lymphoblastoma of the intestine. *J. Med. Research*, 40: 415-431, 1919-20.
10. HEIMANN, G. Die Verbreitung der Krebserkrankung, die Häufigkeit ihres Vorkommens an den einzel. *Arch. f. klin. Chir.*, 57: 937, 1898.
11. HINZ, R. Ueber den Primären Dunndarmkrebs. *Arch. f. klin. Chir.*, 99: 305-362, 1912.
12. JEFFERSON, G. Carcinoma of the suprapapillary duodenum casually associated with preexisting simple ulcer; report of a case, and an appendix of 30 collected cases. *Brit. J. Surg.*, 4: 209-226, 1916.
13. KLOPP, E. J. and CRAWFORD, B. J. Leiomyoma of the small intestine. *Ann. Surg.*, 101: 726-733, 1935.
14. LEICHTENSTERN, O. Ziemssen's Handbuch d. Spec. Pathologie und Therapie. bd. 7, heft 2, 359-555. Leipzig, 1878.
15. LIEBER, M. M., STEWART, H. L. and MORGAN, D. R. Adenosquamous carcinoma of the peri-papillary portion of the duodenum. *Arch. Surg.*, 40: 988-996, 1940.
16. LIU, J. H. Tumors of the small intestine with special reference to the lymphoid cell tumors, twelve cases. *Arch. Surg.*, 11: 602-618, 1925.
17. MAYDL, C. Ueber den Darmkrebs. Wien, 1883. Braumüller.
18. MEDINGER, F. G. Malignant tumors of small intestine; study of their incidence and diagnostic characteristics. *Surg., Gynec. & Obst.*, 69: 299-305, 1939.
19. MEYER, J. and ROSENBERG, D. H. Primary carcinoma of the duodenum; report of 4 cases, with review of literature. *Arch. Int. Med.*, 47: 917-941, 1931.
20. MÜLLER, M. Beiträge zur Kenntniss der Metastasenbildungen maligner Tumoren, nach statistischen Zusammenstellungen aus den Sektionsprotokollen des Bernischen pathologischen Instituts. Inaugural Dissertation, Bern, 1892. 64 pp. 8° Bern, L. Scheim & Co., 1892.
21. NICKERSON, D. A. and WILLIAMS, R. H. Malignant tumors of small intestine. *Am. J. Path.*, 13: 53-64, 1937.

22. NOTHNAGEL, H. Spezielle Pathologie und Therapie; Diseases of Intestines and Peritoneum. Edited by H. D. Rolleston. London 8: 1032, 1904.
23. PARSONS, W. B. and MULLINS, C. R. Carcinoma of Papilla of Vater. *Ann. Surg.*, 102: 1109-1111, 1935.
24. RAGINS, A. B. and SHIVELY, F. L., JR. Sarcoma of small intestine. *Am. J. Surg.*, 47: 96-104, 1940.
25. RAIFORD, T. S. Tumors of small intestine. *Arch. Surg.*, 25: 122, 1932.
26. ROWE, E. W. and NEELY, J. M. Primary malignancy of small intestine. *Radiology*, 28: 325-338, 1937.
27. SHALLOW, T. A., EGER, S. A. and CARTY, J. B. Primary carcinoma of third portion of duodenum. *Surgery*, 16: 939-946, 1944.
28. STAEMMLER, M. Neoplasms of the intestines; two autopsy cases. *Deutsche Chir.*, 46: 296-298, 1923. (Quoted by Ullman and Abeshouse.)
29. STEIN, J. J. Tumors of small intestine; review of literature and report of 8 additional cases. *Am. J. Digest. Dis. Nutrition*, 4: 517-522, 1937.
30. SWENSON, P. C. X-ray diagnosis of the primary malignant tumors of the small intestine. *Rev. Gastroenterol.*, 10: 77-91, 1943.
31. ULLMAN, A. and ABESHOUSE, B. S. Lymphosarcoma of small and large intestines. *Ann. Surg.*, 95: 878-915, 1932.
32. WEBER, H. M. and KIRKLIN, B. R. Roentgenologic manifestations of tumors of small intestine. *Am. J. Roentgenol.*, 47: 243-253, 1942.
33. WEEDEN, W. M. Lymphosarcoma of the gastrointestinal tract; with report of thirteen cases. *Ann. Surg.*, 90: 247-252, 1929.



CHRONIC intestinal stasis with possible absorption of toxic matter may result from intestinal atony, the presence of prenatal or acquired peritoneal bands or sheets of membrane especially over the lower ileum and colon, as *Jackson's membrane* or veil, *Lane's kink* or *Price's elbow*. *Payr's disease* is due to a kink at the splenic flexure of the colon.

From "Principles and Practice of Surgery" by W. Wayne Babcock (Lea & Febiger).

---

---

# Case Reports

---

## SURGICAL MANAGEMENT OF LARGE TUMORS OF THE NECK

### REPORT OF TWO UNUSUAL CASES

CLAUDE F. DIXON, M.D.  
Division of Surgery, Mayo Clinic

AND

RAYMOND E. BENSON, M.D.  
First Assistant in Surgery, Mayo Clinic

ROCHESTER, MINNESOTA

THE modern surgeon seldom sees tumors of enormous size. A few decades ago such tumors were common. In recent years, however, owing to the availability of surgical consultation, improved methods and increased awareness of the patient and physician of the importance of early diagnosis and treatment, tumors are usually relatively small when diagnosed and treated. MacCarty has illustrated this trend statistically. Since 1907, he has measured and weighed all neoplastic lesions removed at the Mayo Clinic. He has found, for example, that uterine fibromyomas in 1912 had an average weight of 1,533 Gm.; in 1941, the average weight was 320 Gm. In 1912, the ovarian tumors averaged 4,410 Gm. in weight and in 1941 they averaged 550 Gm.

In recent months we have seen two unusual tumors of the neck. Both of these were outstanding because of their very large size. The surgical management of large cervical tumors presents some special problems which we wish to discuss.

#### CASE REPORTS

CASE 1. Large cervical and intrathoracic adenomatous goiter with hyperthyroidism; auricular fibrillation and congestive cardiac decompensation: subtotal thyroidectomy: The patient, a white woman, aged sixty-two years, entered the Mayo Clinic on September 15, 1944, complaining of dyspnea, palpitation, swelling of the ankles and a large tumor of the neck. She stated that forty-four years prior to

admission, when she was eighteen years of age, she had first noted a small cervical mass in the region of the thyroid gland. The tumor had shown little tendency to enlarge except during pregnancy. With each of her six pregnancies the mass had grown rapidly in size. Postpartum the tumor always seemed to stop growing but it did not regress in size. Consequently, twenty years ago at the time her last child was born, the tumor was approximately the size of a small grapefruit. In the ensuing seventeen years little change was noted in the size of the mass and it did not cause symptoms except for the discomfort associated with its weight. In 1941, three years before admission, the tumor began to undergo progressive and rapid enlargement. In June, 1944, intermittent diarrhea and indigestion developed. The patient noticed that she was dyspneic on exertion, that she could not breathe well when lying flat in bed and that her heart beat was rapid and disturbing. Edema of the ankles became evident and she rapidly lost strength. All of these symptoms gradually became worse and finally forced her to seek medical aid.

Physical examination revealed a dyspneic, obviously ill white woman with a remarkably large tumor of the neck. The tumor was composed of a mass in the midline the size of an infant's head and two large lateral lobes of somewhat smaller dimensions. The heart was enlarged and in the state of auricular fibrillation. The apex pulse was 150, the radial pulse 130 beats per minute. There were many moist and crepitant râles throughout both pulmonary fields. The liver was enlarged and palpable 8 cm. below the right costal margin and there was moderate pitting edema of both ankles.

Roentgenographic examination of the neck revealed a very large superficial cervical mass, which extended substernally. There were marked compression of the trachea and deviation of it to the right. Roentgenograms of the thorax showed cardiac enlargement and bilateral pulmonary congestion. The electrocardiogram showed typical auricular fibrillation with a ventricular rate of 150 beats per minute. There was retention of dye, grade 3 (on the basis of 1 to 4, in which 1 designates the mildest and 4 the most severe condition), to the bromsulfalein liver function test. The basal metabolic rate was +49 per cent. The concentration of hemoglobin was 12.7 Gm. per 100 cc. of blood and leukocytes numbered 6,400 in each cubic millimeter of blood.

A diagnosis of adenomatous goiter with hyperthyroidism, auricular fibrillation and congestive cardiac decompensation was made.

The patient was hospitalized and treated medically for twenty-two days prior to surgical intervention. Rest in bed, compound solution of iodine (Lugol's solution), diuretics, sedatives and digitalization with lanatosid-c resulted in great improvement in her general condition. By the time of surgical intervention the peripheral edema and pulmonary congestion had entirely disappeared and the radical pulse was consistently less than 100 beats per minute. The patient was relieved of her dyspnea, palpitation and orthopnea. The basal metabolic rate was reduced to +18 per cent and repetition of the liver function test showed reduction in retention of dye to grade 2 (on the basis of 1 to 4).

Subtotal thyroidectomy was performed on October 7, 1944, with the patient under local (procaine hydrochloride 0.5 and 1 per cent), nitrous oxide and oxygen anesthesia. A large elliptic area of skin over the center of the mass was excised. The platysma muscle was divided and the ribbon muscles were separated and retracted. By careful dissection just above the suprasternal notch the trachea was located and its position marked by inserting a fine catgut suture, with ends left long, into the pretracheal fascia. The right superior thyroid vessels were isolated, doubly ligated and divided. The right inferior thyroid artery was ligated and then the substernal portion of the right lateral lobe was elevated. Similar procedures were carried out on the left side and the entire tumor mass was removed. At the conclusion of the opera-

tion all adenomatous tissue had been extirpated. Apparently normal thyroid tissue equal to one-half to three-fourths of a normal sized



FIG. 1. Case 1. Adenomatous goiter with multiple degenerating and cystic colloid and fetal adenomas; weight 1,075 Gm.

lobe was preserved on each side of the trachea. A small gauze wick was inserted as a drain and the skin was closed with metallic clips.

Examination by the pathologist showed that the tumor weighed 1,075 Gm. The main mass of tissue removed measured 14 by 14 by 8 cm. (Fig. 1.) Grossly and histologically the tumor was composed of multiple fibrous, hyaline, granular, hemorrhagic and cystic degenerating colloid and fetal adenomas in a colloid thyroid.

Convalescence was essentially uneventful. The patient left the hospital on the eighth postoperative day and was dismissed from our care on October 31, 1944, twenty-four days after operation. At the time of dismissal she was feeling well, there had been no recurrence of her previous symptoms and, although auricular fibrillation persisted, the radial pulse was 70 to 80 beats per minute. Continued oral digitalis therapy was recommended.

*Comment on Case 1.* The redundant skin which will remain after removal of a very large cervical tumor should be excised at the beginning of the surgical procedure and the skin flaps fashioned so that they can be approximated without undue laxness. If there is doubt as to whether or not removal of the tumor can be



consummated, a straight line incision which can be hurriedly closed is best. This has the disadvantage, however, of making necessary a repetition of the time consuming procedure of securing hemostasis in the skin and subcutaneous tissues at the conclusion of the operation when the skin flaps are reconstructed.

Adequate exposure is a paramount necessity when one is operating on patients who have very large tumors of the neck. It is more important for the surgeon to be able to visualize easily the structures on which he is working than for the patient to have a small scar. To facilitate exposure the senior author routinely divides the deep cervical fascia transversely and ligates and sections the anterior jugular veins. These structures are then reflected along with the skin, subcutaneous tissues and platysma muscle. If the ribbon muscles cannot be easily retracted out of the operative field, they may be cut transversely and reunited at the conclusion of the operation. When the goiter is very large, however, these muscles are usually so thinned out and stretched that they are easily retracted.

After the skin, subcutaneous tissues, platysma muscle, deep cervical fascia and anterior jugular veins have been reflected and the ribbon muscles separated or divided, the trachea should be located. Large goiters not only cause deviation of the trachea but also frequently compress and soften it. There is considerable danger of tracheal collapse or further compression during manipulations incident to removal of the tumor. Immediate tracheotomy may be necessary and it is best to know the exact position of the trachea before the resection is begun. Blunt dissection immediately above the upper end of the sternum will usually locate it. A fine catgut suture with ends left long, placed in the pretracheal fascia, will serve as a guide during the operation. Furthermore, if it is brought out through the incision in the skin, it will guide the surgeon in case subsequent tracheotomy is necessary.

If a portion of the goiter is intrathoracic, the superior pole of the thyroid and the superior thyroid vessels should be isolated, doubly ligated and divided before one attempts to elevate the intrathoracic portion. This procedure facilitates mobilization of the lateral lobe and intrathoracic portion. If the inferior thyroid arteries are also ligated as an initial step, hemostasis will be facilitated.

The remainder of the procedure does not differ materially from the usual subtotal thyroidectomy.<sup>2</sup> It should be noted, however, that the fact that the original goiter was large does not justify a less thorough removal of the gland than if the goiter had been small. Regardless of whether the enlargement of the thyroid is great or small, the tissue remaining at the conclusion of the operation should not exceed the equivalent of one-half to one normal sized lobe. The only exception to this statement occurs in those cases in which in addition to a goiter there is severe nonspecific thyroiditis. In such cases, especially if the goiter is of the exophthalmic type, hypothyroidism or myxedema is prone to develop postoperatively.<sup>8</sup> In such cases it is permissible to leave a somewhat greater amount of thyroid tissue. We do not know of any direct evidence to prove that this practice will minimize the incidence of postoperative hypothyroidism, however. In either event all adenomatous tissue must be extirpated.

Whenever a large goiter is removed, the cavity occupied by the gland will persist in part as a dead space at the conclusion of the operation. Such potential spaces are most often encountered when a portion of the tumor is intrathoracic. Unless such cavities are drained, serum will accumulate and give rise to postoperative complications. The insertion of drains circumvents this possibility. For this purpose a strip of finely woven gauze seems preferable to the ordinary rubber drains, for in addition to allowing the escape of serum it may aid in hemostasis.

This patient also illustrates many points in the preoperative medical management of hyperthyroid patients suffering from

In the intervening years it had grown gradually until it reached such tremendous proportions that the patient wearied of carrying the heavy

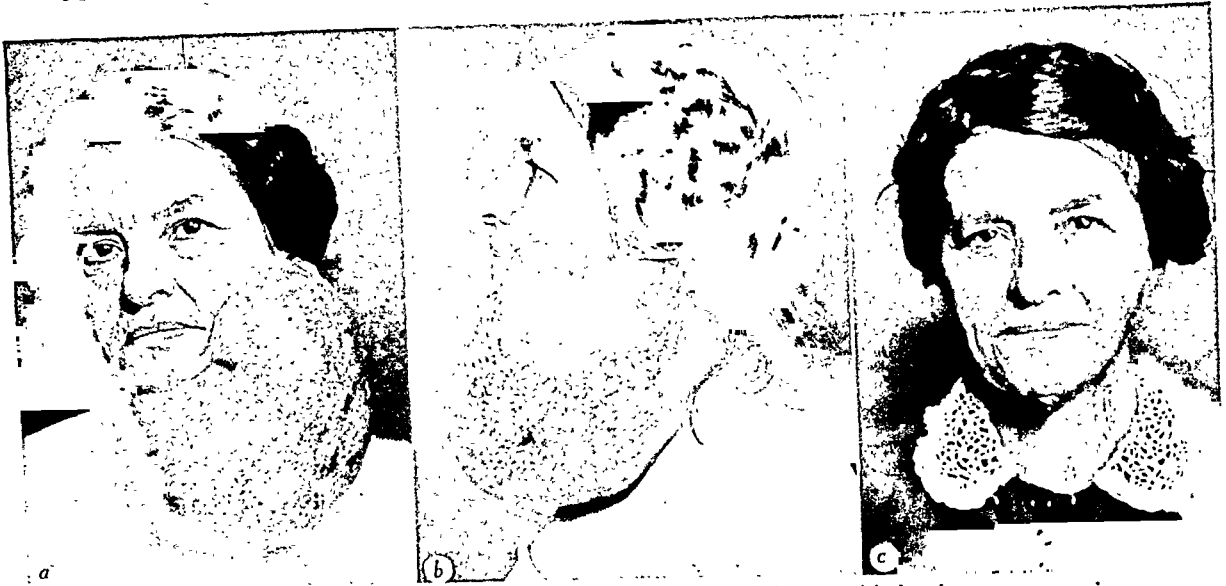


FIG. 2. Case 11. *a* and *b*, front and lateral views of large mixed tumor of the parotid gland; *c*, postoperative appearance of the patient.

decompensated cardiac disease. In the excellent publications of Haines, Pemberton and Miller and Davis and Howell this phase of the problem is fully discussed. We wish to state, however, in agreement with these authors, but contrary to the belief of some physicians, that the preoperative use of compound solution of iodine and preoperative digitalization in properly selected cases are of definite value for many persons suffering from adenomatous goiter and hyperthyroidism.

**CASE II.** Huge mixed tumor of parotid gland; surgical excision. The patient, a white woman, aged sixty-one years, entered the Mayo Clinic on July 15, 1944, for treatment of a large tumor of the left side of the face and neck. She stated that forty-three years before, when she was eighteen years of age, she first noticed a small tumor about the size of a walnut in the left parotid region. Two years later it had grown appreciably and surgical excision had been performed. The patient did not know the pathologic type of the tumor removed at that time. Subsequently she was well and without evidence of recurrence for twenty-three years. Eighteen years prior to admission another small swelling in the left parotid region was noticed.

weight of the tumor and sought medical advice. Aside from the discomfort of supporting the mass there had not been pain, dysphagia or other symptoms.

Physical examination revealed a well developed white woman. A tumor mass, which was almost as large as her head, protruded from the left side of the face and neck. (Fig. 2A and B.) The tumor was of firm, rubbery consistency and was distinctly nodular. It was relatively immobile and seemed fixed to the mandible and the deep structures of the neck. The overlying skin was atrophic and scarred and in some areas was adherent to the growth. There was no significant enlargement of the regional lymph nodes. The facial nerve was not affected. The remainder of the physical examination gave essentially negative results.

Roentgenograms of the tumor revealed regions of calcification. Roentgenograms of the thorax, the flocculation test for syphilis and urinalyses all gave negative results. The concentration of hemoglobin was 12.3 Gm. per 100 cc. of blood and leukocytes numbered 11,600 in each cubic millimeter of blood. Surgical treatment was advised and accepted.

On July 22, 1944, the patient was operated upon while she was under nitrous oxide, oxygen and ether anesthesia. The anesthetic agents were administered through an intratracheal

tube. An incision was made around the circumference of the growth in such a manner as to preserve all possible healthy appearing and

days for radium therapy to the operative site. She was dismissed from our care after satisfactory healing of the wound and in good

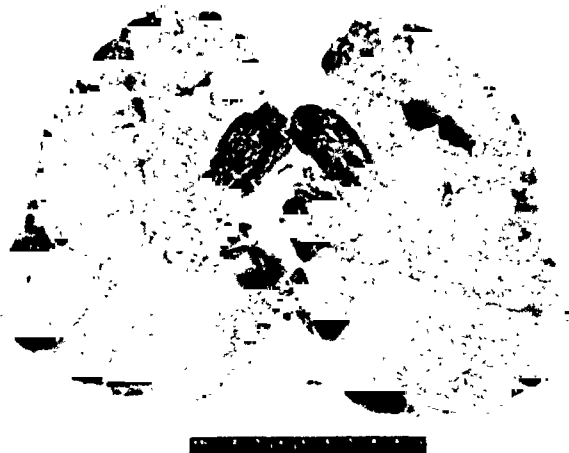


FIG. 3. Case 11. Adenocarcinoma of the parotid gland of the mixed tumor type; weight 2,100 Gm.

nonadherent skin. After the subcutaneous tissues and platysma muscle had been incised, the tumor was retracted upwards and medially. The internal, common and external carotid arteries, the vagus nerve and the internal jugular vein were identified and isolated. The tumor was then removed. During the resection it was necessary to sacrifice the lingual, external maxillary and facial arteries, the posterior belly of the digastric muscle and a portion of the sternocleidomastoid and omohyoid muscles. We had anticipated having to excise most of the facial nerve and had so informed the patient but at operation it was found that we could dissect well around the tumor and into apparently normal tissue of the parotid gland without disturbing any of the major divisions of this nerve. At the conclusion of the procedure 2 Gm. of sulfathiazole were dusted into the incision and a small strip of plain gauze was inserted as a drain. A small plastic procedure facilitated satisfactory approximation of the skin flaps.

Postoperatively, it was evident that there was weakness of the small facial muscles at the angle of the mouth on the left side due to interruption of the small inframandibular twig of the seventh cranial nerve. This has persisted but has caused the patient very little inconvenience. Convalescence was otherwise essentially satisfactory. The patient left the hospital on the eleventh postoperative day and was subsequently rehospitalized for three additional

general condition on August 15, 1944, twenty-four days after operation. She has remained well since. Figure 2c shows her postoperative appearance.

Examination by the pathologist showed that the tumor weighed 2,100 Gm. It measured 20 by 14 by 12 cm. It was grayish white and of solid consistency with a few small cystic regions. (Fig. 3.) Histologically, it was an adenocarcinoma, grade 2 (Broders' method), of the mixed tumor type.

*Comment on Case 11.* Most pathologists agree that mixed tumors of the parotid gland are almost invariably malignant. Usually they are adenocarcinomas of grades 1 or 2 according to Broders' classification. In spite of their histologically malignant appearance, however, they very rarely metastasize. Mixed tumors of the salivary glands frequently recur after removal and they may become locally invasive and occasionally involve the regional lymph nodes. Distant metastasis from these tumors is very uncommon, however. Only a few such cases have been recorded in the literature.<sup>6</sup> The tumor in the present case had been present for eighteen years and had grown to a very large size but still there was no discernible evidence of spread to regional lymph nodes or distant structures.

The first surgical problem in association with this case was the fashioning of adequate skin flaps. Much of the skin over the surface of the growth was thinned, atrophic, scarred and adherent to the tumor. It would have been unwise to attempt to save such skin. Its blood supply was very poor and, because it was adherent to the tumor, to have preserved it would have been to subject the patient to unnecessary risk of cutaneous recurrence in the future. Accordingly all the diseased skin was excised. In spite of this, primary closure of the incision was obtained without undue tension.

The next step in operating on patients of this type is to locate and isolate those structures in the neck which it is essential or highly desirable to preserve. Of prime importance is the avoidance of injury to the internal carotid artery. Interruption of this artery among adults often leads to hemiplegia and permanent damage to the brain. It is safer to ligate the common carotid artery than the internal carotid, for when the common carotid is ligated the internal branch receives some collateral circulation via the external carotid artery. Other structures which it is highly desirable to preserve include the external and common carotid arteries, the vagus nerve and the ansa hypoglossi. The internal and external jugular veins, as well as the superior thyroid, lingual and external maxillary arteries and other branches of the external carotid arteries, may be sacrificed without apparent deleterious effect. The facial nerve should be preserved if possible. It is fairly frequently necessary to remove portions of some of the branches of this nerve in order to obtain complete removal of the tumor. This is more often necessary when the parotid tumor is large or recurrent than in other instances. In the present case it was gratifying to find that the seventh nerve could be left intact except for the small inframandibular branch which controls the small muscles at the angle of the mouth.

After the essential structures are isolated

the tumor is usually easily removed. Perfect hemostasis and skin suture complete the task.

Postoperative local radium therapy, such as was given in this case, is probably advisable for most mixed tumors of the parotid gland. Recurrent growths sometimes occur after apparently complete surgical removal. Radium therapy may minimize this tendency. It used to be customary to swab out the bed of the tumor with a caustic solution at the completion of the operation in an attempt to destroy any residual malignant cells. Harrington's solution was commonly employed.<sup>7</sup> This obviously has deleterious effects on the surrounding normal cells as well as on the tumor cells and may delay healing of the incision. At the present time it would seem that properly applied radium therapy will be more effective in destroying any residual neoplastic cells than any other form of treatment. It is probably true, however, that if complete surgical extirpation is not obtained other forms of therapy will simply delay and not prevent recurrences.

#### SUMMARY

Two cases of unusually large tumors of the neck are presented. The first tumor was a hyperfunctioning adenomatous goiter, which weighed 1,075 Gm. The second was an adenocarcinoma of the parotid gland of the mixed tumor type, which weighed 2,100 Gm.

In the surgical management of large cervical tumors adequate exposure is essential. In removal of large goiters the trachea should be located in order to facilitate tracheotomy if that becomes necessary. If part of the goiter is intrathoracic, the superior pole of the thyroid and the superior thyroid vessels should be isolated, doubly ligated and divided before one attempts to elevate the intrathoracic portion. The dead space left by removal of the goiter should be drained with a strip of finely woven gauze.

Mixed tumors of the parotid gland are almost invariably malignant histologically

but rarely metastasize. In the removal of large parotid tumors avoidance of injury to the internal carotid artery is of prime importance. It is safer to ligate the common carotid artery than the internal carotid. The facial nerve should be preserved if possible. Postoperative radium therapy is advisable.

#### REFERENCES

1. DAVIS, A. C. and HOWELL, L. P. Medical management of diseases of the thyroid gland. *M. Clin. North America*, 24: 991-1018, 1940.
2. DIXON, C. F. Technic of thyroidectomy. *Surg. Clin. North America*, 23: 1083-1090, 1943.
3. HAINES, S. F. Adenomatous goiter with hyperthyroidism. *Tr. Am. Ass. Study Goiter*, pp. 198-204, 1938.
4. MACCARTY, W. C. Diagnostic and prognostic surgical pathology. *J. Internat. Coll. Surgeons*, 5: 369-374, 1942.
5. PEMBERTON, J. DEJ. and MILLER, J. M. Surgery for thyroid disease associated with cardiac disease. *Tr. Am. Ass. Study Goiter*, pp. 32-37, 1940.
6. PERRIN, T. L. Mixed tumor of the parotid with metastases. *Arch. Path.*, 33: 930-934, 1942.
7. SISTRUNK, W. E. Mixed tumors of the parotid gland. *Minnesota Med.*, 4: 155-160, 1921.
8. WILSON, W. D. and MAYO, C. W. Postoperative myxedema. *Surgery*, 7: 117-121, 1940.



NECK dissection for removal of diseased lymph nodes may be indicated in Hodgkin's disease, tuberculous adenitis, primary endothelioma, metastatic carcinoma, carcinoma arising from a branchial cleft, and rarely for lymphosarcoma and tumors of the carotid body. This dissection depends upon the extent and character of the disease.

From "Operations of General Surgery" by Thomas G. Orr (W. B. Saunders Company).

# PENICILLIN TREATMENT OF GAS GANGRENE\*

C. M. HARRIS, M.D.      AND  
Passed Assistant Surgeon (R),  
U. S. Public Health Service

L. R. LEVITON, M.D.  
Assistant Surgeon (R),  
U. S. Public Health Service

BELLE GLADE, FLORIDA

THE value of penicillin in the treatment of gas gangrene infections has been established experimentally,<sup>1,2</sup> and favorable clinical reports have been published in American literature.<sup>3,4</sup> Lyons<sup>3</sup> has stressed the necessity of the local use of penicillin in addition to systemic therapy. Kepl<sup>3</sup> has reported two cases and McKnight<sup>4</sup> reported one case in which penicillin was used locally and intravenously with good results. Specific antiserum was also used in these cases.

From extensive experience with experimental gas gangrene infections in dogs, Dowdy<sup>2</sup> has reported favorable results using sulfadiazine both as a prophylactic and therapeutic measure against most of the pathogenic *Clostridium* organisms except *Clostridium novyi*. The latter organism was affected little or not at all. Penicillin, on the other hand, was found to be very effective against all the *Clostridium* group used, if therapy was begun before the infection was too far advanced. Polyvalent antiserum was also favorably reported in this series, and the combination of sulfadiazine, penicillin, and antiserum was recommended as the most effective therapy of severe cases, along with adequate surgery.

The difficulties in the clinical application of experimentally established data are well recognized. Numerous clinical studies attest to the lack of favorable results in the treatment of gas gangrene with antiserum and sulfadiazine, which these experimental findings would lead one to expect. The encouraging reports of the usefulness of penicillin in this infection have as yet not been established by sufficient clinical trial.

Three cases are presented below in detail which seem to indicate the favorable effect of penicillin on clinical gas gangrene infections. None of these patients received antiserum. One of them (Case II) received systemic penicillin and local surgery without sulfonamide therapy. The two others received sulfamerazine and penicillin. In only one of our cases was any amputation necessary, and this was done in the course of a thorough débridement of completely necrotic tissues of the foot. This amputation of the toes was not an effort to amputate above the infection but was necessitated by an inadequate local blood supply to the part.

In all three cases the rapidly spreading infection, with crepitation and characteristic black, liquefying necrosis of the muscles involved, left no doubt of the presence of a gas gangrene infection. In all three cases the presence of a *Clostridium* organism was established by finding a Gram-positive bacillus which formed gas in anaerobic culture. While by far the majority of such cases in civilian life are caused primarily by *Clostridium Welchii* infections, unfortunately in none of these cases were we able to obtain sufficiently pure cultures to identify positively which member of this group was present. The difficulties of this bacteriological procedure in ordinary hospital laboratories has been repeatedly stressed.<sup>2,6</sup>

## CASE REPORTS

CASE I. (Fig. 1.) C. B., a thirty-year old Negro man entered the Belle Glade Migratory Labor Hospital on May 9, 1944, complaining of a swollen scrotum. Since 1937, he had noticed progressive difficulty of urination, and almost

\* From the Migratory Labor Hospital, Belle Glade, Florida.

continual purulent urethral discharge. The present attack began five days before admission with a painful swelling of the right testicle.

In 1942 he took anti-syphilitic injections for two months.

Examination on admission revealed an under-

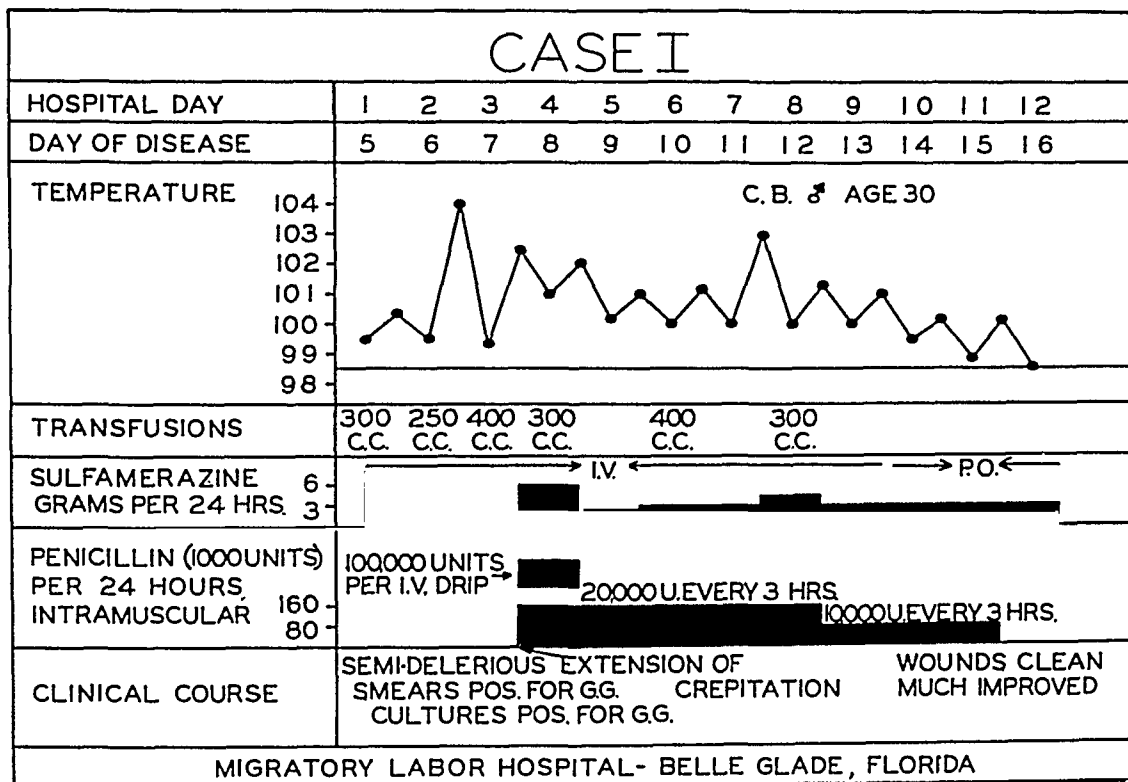


FIG. 1.



FIG. 2 Case I. A, this picture taken three days after extensive incisions were made indicates the extent of the subcutaneous crepitation. The skin of the scrotum has completely sloughed away. A suprapubic tube is in place. B, twenty-five days later most of the incisions have healed and healthy granulations appear on the anterior abdominal wall and scrotum. A retention catheter is shown in a posterior urethrostomy. C, the skin grafts of the anterior abdominal wall were successful despite seepage of urine through the open cystostomy shown.

The swelling progressed to involve the entire scrotum, and he had increasing difficulty of urination. He had had a high fever with numerous chills for the past four days.

nourished, prostrate Negro man, with a high fever, appearing gravely ill and semi-delirious. The temperature was 104°F. and the pulse 140. Except for a generalized non-tender

lymphadenopathy the significant physical findings were limited to the scrotum which was symmetrically swollen to 12 by 15 by 10 cm.

entire abdominal wall, and subcutaneous crepitation extended up toward the left axilla as high as the seventh intercostal space and

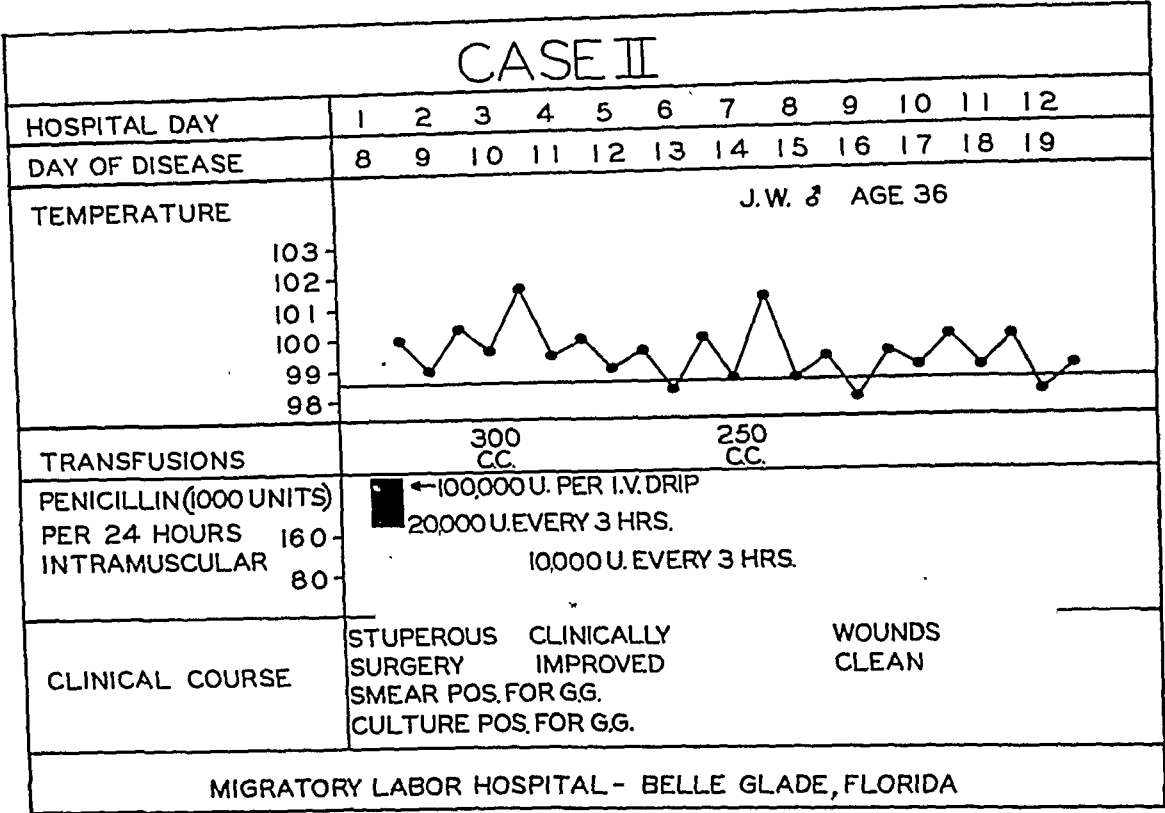


FIG. 3.

Several areas of the skin over the scrotum were gangrenous, and there was a very foul penetrating odor. Pitting edema was present just above the symphysis pubis, and the glans penis was deformed from old ulcer scars. Light probing with a filiform sound revealed an impassible stricture of the posterior urethra. The diagnosis on admission was posterior urethral stricture with urinary extravasation.

Sodium sulfamerazine and fluids were begun intravenously, and a suprapubic cystostomy was done shortly after admission, following which the scrotum was drained by "tiger claw" incisions. The extensive black liquefying necrosis of the scrotal structures suggested gas gangrene infection, and cultures and smears were taken. The smears showed a mixed infection containing short, blunt Gram-positive rods which showed definite gas formation after twelve hours anaerobic culture. These findings are consistent with the Clostridium group of bacilli. Twenty-four hours later there was extension of the liquefying necrosis over the

downward over the upper half of the left thigh. The suprapubic incision was grossly infected and had to be reopened widely. There was marked abdominal distention and vomiting with absent peristalsis suggestive of peritoneal involvement. There was phlebitis of the left femoral veins with massive edema of the left thigh and leg. This spread occurred despite adequate functioning of the suprapubic tube. Extensive incision and drainage was done, as shown in Figure 2A, and 1 per cent hydrogen peroxide irrigation begun through Dakin's tubes sutured in the wounds. Penicillin was begun forty-eight hours after admission, and 100,000 units were given by slow intravenous drip during the first twenty-four hours along with 20,000 units given every three hours intramuscularly. The total dose for the first twenty-four hours was 260,000 units. During the next four days 20,000 units were given intramuscularly every three hours, and then reduced 10,000 units every three hours for



three days more. A total of 1,200,000 units were used.

There was no further extension of the infec-

Belle Glade Migratory Labor Hospital on August 7, 1944, complaining of injury to both legs. Eight days prior to admission both feet



FIG. 4. Case II. A, the foot as it appeared on admission showing gangrene of the toes. The discoloration extends well up on the foot. B, this picture forty-eight hours after operation shows that the necrotic toes have been amputated and the volar aspect of the foot opened widely and débrided. Dakin's irrigation tubes are shown. C, the foot is shown twenty-two days after admission. Skin graft was done with satisfactory results shown in Figure 4D.

tion, and general improvement was noticeable at the end of the third day. Healthy red granulations appeared promptly. (Fig. 2B.)

The entire skin of the scrotum and much of the anterior abdominal wall sloughed away and had to be skin grafted, which was done with results shown in Figure 2C.

The patient died four months later of causes unrelated to his gas gangrene infection.

CASE II. (Fig. 3.) J. W., a thirty-six-year old Negro Jamaican was admitted to the

were caught beneath a moving train. He had been treated elsewhere since the accident where sulfathiazole was given and a cast applied to the right leg. Examination on admission revealed an acutely ill, colored male, with a high fever, and a cast on the right leg below the knee. The left foot was discolored and obviously gangrenous to the mid-metatarsal level dorsally, and the entire volar aspect was a glistening black-green with subcutaneous crepitation. (Fig. 4A.) There was a very foul odor.

Fluids were given intravenously and a débridement done under spinal anesthesia. The toes were found to be completely devitalized

There was definite clinical improvement in forty-eight hours, and in four days the foot had a remarkably healthy red granulating

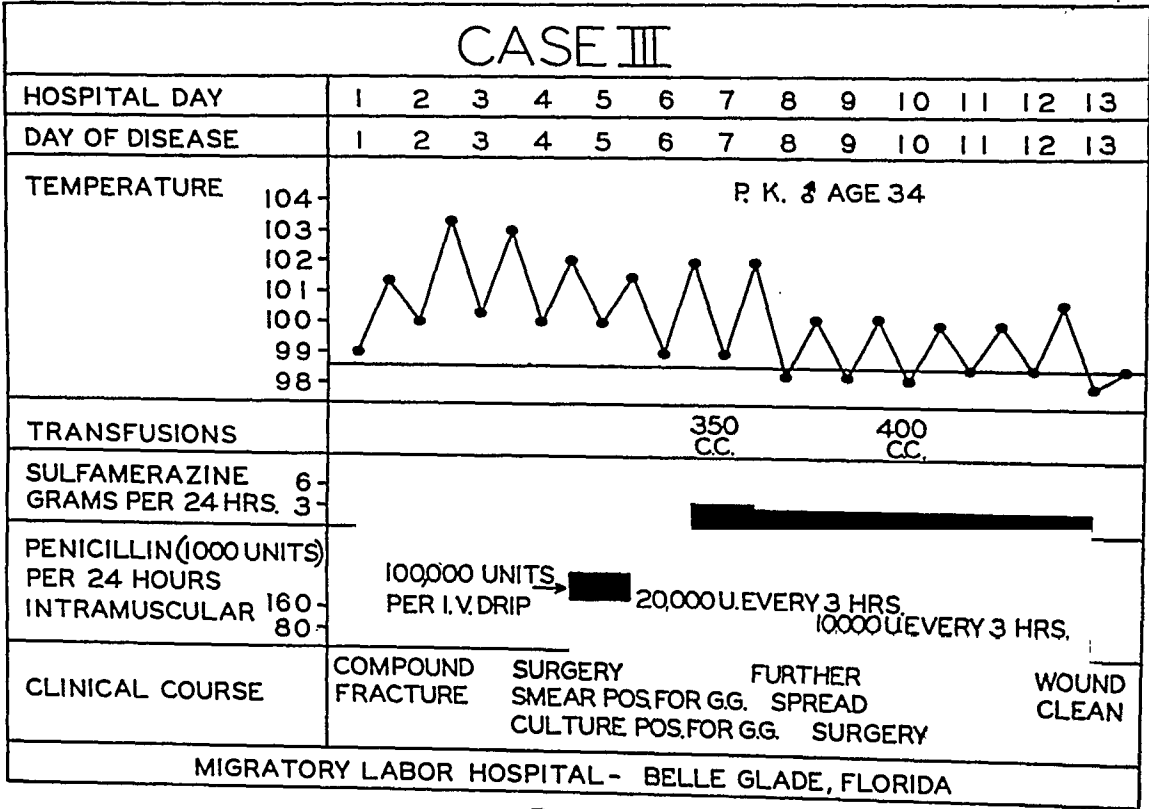


FIG. 5.

and had to be amputated just proximal to the head of the metatarsal bones. The muscle bellies on the volar aspect were black and liquefied and had to be sacrificed well back beneath the calcaneus. (Fig. 4B.) Dakin's irrigation tubes were sutured in the wound, and 1 per cent hydrogen peroxide irrigations begun. Smears taken from the foot showed mixed infection, with numerous short Gram-positive rods with blunt ends, consistent with the Clostridium group of organisms. Anaerobic cultures showed gas formation in ten hours.

Penicillin was begun six hours after admission and 100,000 units were given slowly by intravenous drip during the first twenty-four hours along with 20,000 units intramuscularly every three hours. The total dosage for the first twenty-four hours was 260,000 units. This intramuscular dose was continued for two days when it was reduced to 10,000 units every three hours for five days more. The total dose given was 1,000,000 units. No sulfonamide or specific antiserum was given.

base. (Fig. 4C.) Split-thickness skin grafts were done with results shown in Figure 4D.

CASE III. (Fig. 5.) P. K., a thirty-four-year old Negro Jamaican was admitted to the Belle Glade Migratory Labor Hospital on September 4, 1944, three hours after having his left leg crushed beneath a tractor. On admission there was a severely compounded, comminuted fracture of the left tibia and fibula in their middle third.

The wounds were débrided and thoroughly irrigated with saline and sulfanilamide applied locally. Steinmann pins were placed through the tibia above and below the fracture, and the leg manipulated and a circular plaster cast applied. Mixed prophylactic antitetanus and gas gangrene serum were given on admission, and intravenous sulfamerazine begun. Forty-eight hours later the temperature was 103°F. and a window was cut in the cast revealing a glistening edema of the entire leg with local sloughing. A thick foul-smelling pus was discharging from the wounds. There was extensive subcutaneous crepitation. Smears from the pus

showed mixed infection with short Gram-positive rods, and in twelve hours the anaerobic cultures showed gas formation.



FIG. 6. Case III. This film shows the leg six days after the second operation. The granulations shown are fairly clean, and the edema has subsided.

"Tiger claw" type incisions were made and revealed a black liquefying necrosis of the muscle bellies, many of which had to be sacrificed. Dakin's tubes were sutured in the incisions and 1 per cent hydrogen peroxide irrigations begun. Penicillin was started the next morning and 100,000 units given intravenously by slow drip during the first twenty-four hours, with 20,000 units given intramuscularly every three hours. (The total penicillin given for first twenty-four hours was 260,000 units.) This intramuscular dose was continued for thirty-six hours when local spread of the crepitation upward was noted. More radical incisions were made, and further débridement of the necrotic deep muscles was

done. Following this there was steady general improvement. No further spread occurred, and the incisions rapidly developed healthy granulations. (Fig. 6.)

The 20,000 units of penicillin was continued every three hours intramuscularly for two days and then reduced to 10,000 every three hours for five days. Total penicillin used was 1,000,000 units. Sulfamerazine was discontinued when the penicillin was started, but was begun again at the time of the second operation. Its value was questionable.

No antiserum was given except prophylactically, and no penicillin was used locally. Roentgenogram on September 18, 1944, revealed the changes of early osteomyelitis of the tibia.

#### SUMMARY

1. Three cases of gas gangrene in which the patients were treated with penicillin are presented. One of the patients received penicillin alone, and the other two sulfamerazine in addition.

2. Systemic penicillin without local application was used with satisfactory results in all patients.

3. In the cases presented the use of penicillin appeared to reduce the extent of radical surgery usually necessary.\*

#### REFERENCES

1. McINTOSH, J. and SELBY, F. R. Zinc peroxide, proflavine, and penicillin in experimental *Cl. Welchii* infection. *Lancet*, 2: 750, 1942.
2. DOWDY, ANDREW H., SEWELL, ROBERT L. and VINCENT, JAMES G. The prophylaxis and therapeutic of Clostridial infections. *New York State J. Med.*, 44: 1890-1896, 1944.
3. KEPL, M., OCHSNER, A. and DIXON, J. L. Two cases of *Clostridium Welchii* treated with penicillin. *J. A. M. A.*, 126: 96-97, 1944.
4. MCKNIGHT, W. B., LOEWENBERG, R. D. and WRIGHT, V. L. Penicillin in gas gangrene. *J. A. M. A.*, 123: 360, 1944.
5. LYONS, CHAMP. Penicillin therapy of surgical infections in the U. S. Army. *J. A. M. A.*, 123: 1007-1018, 1943.
6. ZINSSER and BAYNE-JONES. *Textbook of Bacteriology*. P. 630. New York, 1928. D. Appleton.

\* Med Scott Brown, M. T., made the bacteriological studies and drew the charts of the clinical courses of these cases.

# PRIMARY ACTINOMYCOSIS OF THE LUNG\*

WITH SECONDARY INVOLVEMENT OF THE KIDNEY AND BRAIN PRESENTING  
ABNORMAL PULSE AND TEMPERATURE REACTIONS

HARRY E. KASTEN, M.D.

BELOIT, WISCONSIN

THE causative organism of actinomycosis in man is *Actinomyces bovis* which is a fungus and one of the many microscopic members of the plant kingdom. It may be said in general that the plant kingdom consists of four major groups: the thalli, the mosses, the ferns and the seed plants. The thalli may be further divided into algae and fungi depending upon the presence or absence of chlorophyll. Algae, because they contain chlorophyll, may carry on a free and independent existence. Fungi, however, lack this very important substance and, therefore, are either parasitic, living on other organisms or saprophytic, living on the dead remains of other organisms.

Mycotic diseases of man may be superficial or deep seated. The superficial infections or dermatomycosis are due to the dermatophytes and may be classified as *Microsporon*, *Epidermophyton*, *Trichophyton* and *Monilia*. The deep seated infections are due to *Actinomyces*, *Sporotrichum*, *Blastomyces*, *Coccidioides* and *Phialophora* and are characterized essentially by granulomatous reactions. Any of these might cause primary fungus infections in those who till the soil or who contact plants, hay, hay-straw, animals or their by-products, feathers, silk, wool and leather.

Superficial fungus infections are acquired by those who tend and care for pets, swimming pools and bath house attendants, dairymen and herders, bakers, preserve packers, fruit handlers and dishwashers. The deep seated infections are usually found in tillers of the soil, cattlemen, florists, horticulturists, wood-handlers and research workers.

Actinomycosis in man was first reported by Israel in 1878 and since that time has been observed with increasing frequency.

The occurrence of actinomycosis in the human, according to Cullen and Gross, is seen most frequently in the region of the face, jaw or neck, comprising 60 per cent of instances. About 20 per cent of occurrences are found in the abdominal cavity particularly in relation to the cecum or appendix or the adjacent abdominal wall. In the next 15 per cent of instances the primary focus is in the bronchial tree, the pulmonary tissue and the chest wall. The remaining 5 per cent are confined to the skin or other viscera.

In the generalized forms of actinomycosis the primary lesion in the majority of instances is found in the lung. The most noteworthy fact in regard to the primary lesion is that it may be so small as to be missed entirely. It is frequently missed in the roentgenogram made of the chest. Likewise it is commonly overlooked at autopsy even at the hands of the most skilled pathologist.

Metastatic lesions may be few or may involve many organs. The brain and the kidney head the list of most frequent sites of involvement.

The clinical course frequently presents a disease of marked chronicity in which the symptoms of malaise, fatigue, low grade fever and weight loss may be so lacking in importance as to disarm the clinician completely. It is only after the symptoms referable to the infected organs become sufficiently prominent and after the most exhausting diagnostic procedures are carried out that the true nature of the illness may be suspected only to be later con-

\* From the Department of Urology, Beloit Municipal Hospital, Beloit, Wisconsin.

firmed, after operation or at the autopsy table.

Attention is directed to the problem which is sometimes posed for the surgeon. Since many of the reported cases of actinomycosis of the kidney also had involvement of the brain, all of course terminated in death. Thus there is presented for the surgeon the most difficult and vexing problem of whether or not to operate in some of these puzzling cases.

It is imperative that the most painstaking study be made in order that all avenues of infection be thoroughly explored before deciding on a course of action.

Human nature being what it is, it is doubtful if an autopsy would have been permitted in the case here reported had surgery of the kidney been attempted.

The following case report is submitted not because it presents anything new, but rather to re-emphasize the importance of keeping in mind the possibility of actinomycosis in cases which are shrouded in obscurity and in which the symptoms are vague and inconclusive.

#### CASE REPORT

A white male, age forty-four, a carpenter, was first seen during his last illness on February 13, 1943, stating that he had worked only one-half day in February and that he felt tired all the time and had a slight headache. These minor symptoms comprised the sole subjective findings until one week later he began to feel a slight tenderness in the region of the left kidney. The fact in his past history worthy of note was that he had four attacks of pneumonia during his lifetime, three in the past four years, the last one occurring in December, 1942.

On February 19, 1943, despite the apparent minor character of his complaints his general appearance had changed so much for the worse that intensive investigation was instigated. The blood Wassermann and blood cultures were negative. Also negative were agglutination tests for typhoid and undulant fevers. A second blood culture was negative. Urine was negative except for a faint trace of albumin.

By February 23, 1943, a definite renal ten-

derness on the left side could be elicited. The patient was hospitalized and a urological study made.

Examination at the hospital preliminary to a cystoscopic study revealed a temperature range of 97 to 99.2°F., heart rate 60 to 72, blood pressure 120/70. Urine contained a large amount of pus cells, four plus sugar and a heavy trace of albumin.

Blood examination: white blood cells, 28,600, red blood cells, 5,150,000, hemoglobin 95 per cent, blood urea was 14 mg. per 100 cc.

Roentgenogram of the chest revealed infiltration at the root of the right lung, involving particularly the pulmonary tissue adjacent to the larger truncal markings of the inferior bronchial tree. The heart appeared to be moderately enlarged in the ventricular diameter.

Roentgenogram of the kidney, ureter and bladder revealed both kidneys to be enlarged, the one on the left being considerably larger.

Intravenous urogram showed both kidneys to be excreting actively. There was no marked deviation of the renal pelvis from the normal except for some blunting of the calices of the left kidney. The left kidney did not move on respiration.

On February 26, 1943, a cystoscopic examination was performed. At the time of this examination the patient appeared gravely ill. He hiccupped continuously. There was marked restlessness with rolling of the eyes and an apparent inability to see objects clearly. There was a suggestion of stiffness of the muscles of the neck and muscular resistance over the left kidney. At this time the temperature range was from 98.6° to 100.2°F. The pulse range was notable, varying from 60 to 72.

Cystoscopic examination revealed a fairly normal appearing bladder containing heavy pus laden urine. Both ureters were catheterized with No. 6 catheters. Indigo carmine administered intravenously appeared promptly in good concentration from both kidneys. The urine from the left side was grossly pus laden and on culture showed a growth of staphylococci. The type was not determined.

On the basis of the findings a diagnosis of left pyelonephritis with perirenal involvement was made.

The most difficult problem in this confusing case was to arrive at a decision of whether to perform an operation at once or to defer it until a later time.

Because of inconsistencies and confusion in the clinical picture due to the presence of a persistent low fever range and of a low pulse rate which at times dropped to 56 per minute,

The body is that of a tall white male, adult. It is well developed though slightly thin. There is no enlargement of the lymph nodes or thyroid. The external genitalia are normal.

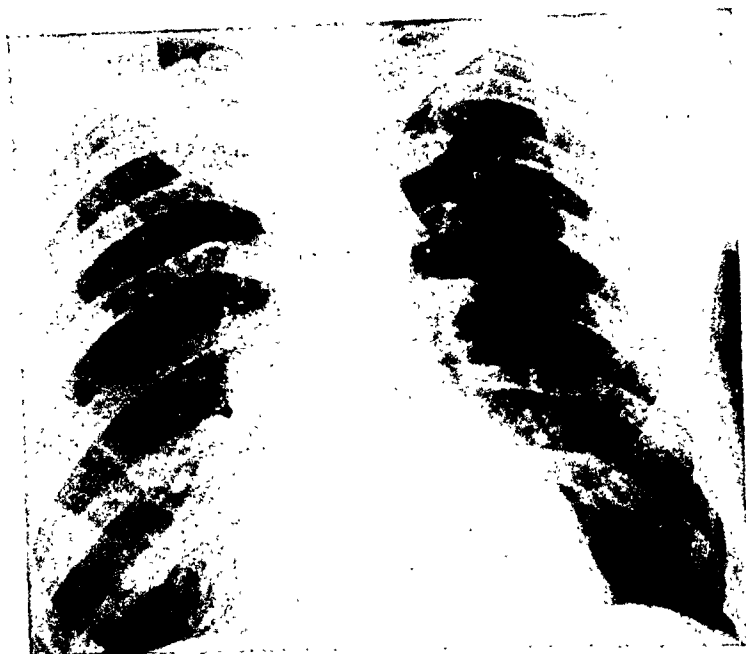


FIG. 1. This photograph of the roentgenogram of the chest revealed only changes that would be expected in a man who had had several attacks of severe respiratory infection. At autopsy the primary focus was found in the region indicated by the arrow.

the persistent hiccough, the visual disturbance, the restlessness and the disorientation and a detectable stiffness of the muscles of the neck and back, operation was deferred to await further clarification of this case. The wisdom of the decision not to operate was borne out by subsequent events.

Spinal taps made on successive days showed the spinal fluid to be under increased pressure and the cell count varied from 350 to 700 cells per cc. Culture of the spinal fluid was negative.

It was concluded from the findings that we were dealing with a perinephritis infection and an involvement of the meninges. Because there was no history of any preceding infection and because the roentgenogram of the chest showed only changes that one would expect to find in any chest of a man who had had several severe respiratory infections, it was believed that the primary infection was in the kidney with a secondary meningitis.

Despite all efforts to improve the patient's condition he rapidly became worse and death ensued on the eleventh day in the hospital.

An autopsy was performed by the hospital staff pathologist. The report is as follows:

There are a few adhesions to the right lung. There is no consolidation. A small firm indurated area is present in the lower anterior border of the right lung. The heart is of normal size. The muscles, vessels, and coronary arteries are not remarkable. The mediastinum is normal.

There is no peritonitis. The viscera are properly situated. The liver and gallbladder show nothing of note. Pancreas and spleen and gastrointestinal tract are essentially normal. The bladder is distended two and one-half inches above the pubic arch. It is filled with clear urine and shows nothing else of note. The prostate is normal; the ureters are also normal. The left kidney is large and distorted. There is a collection of pus outside the capsule of the upper outer third. An adjacent abscess is found in the kidney cortex ( $2\frac{1}{2}$  cm.). This has a ragged necrotic lining. The pus has a greenish-yellow color. The right kidney shows nothing remarkable. It is fairly firm, but has a slightly reddish color. The adrenal glands are normal.

The scalp and skull are negative. The cerebral convolutions are flat and wide and have a pale yellow color. There is some greenish purulent exudate at the base and about the

outlets of the fourth ventricle. There are several abscess pockets in the right frontal lobe. These measure up to 2 cm. in diameter. They contain

suppuration and necrosis with very abundant giant cells, and it seems to be well demonstrated that a similar type of infection is present in all



FIG. 2. Photograph of the roentgenogram of the kidney area showed both kidneys to be larger than normal with the most pronounced enlargement on the right side. This kidney was found to be normal at cystoscopic examination and confirmed at autopsy.



FIG. 3. Intravenous urogram shows both kidneys functioning actively and apparently to an equal degree. The catheterized specimen of urine from the left kidney was grossly infected with staphylococci. Despite this infection the function of the kidney was equal to that of the healthy right kidney. Autopsy revealed the left kidney and brain to be the sites of metastatic infections of actinomycosis.

greenish pus. The ventricles contain a large amount of thin green exudate. This is very marked in the fourth ventricle.

The sections of the brain were taken from the abscess area. They show granulomatous infection with suppuration. Numerous giant cells of Langhans' type are noted. Similar inflammatory reaction is noted in the ependyma and pia.

The section of the lung is from the indurated area described in the gross. It shows an inflammatory process similar to that described in the brain. There is no suppuration. However, the process is more of a granuloma with considerable fibrosis and atelectasis. Giant cells of the same type are noted here also.

The kidney section shows a large area of

of these areas studied. Smears of the pus show the presence of branching filamentous Gram-positive bacilli of the streptothrix or actinomyces type. This is probably in *Actinomyces* asteriodes.

Diagnosis: Perirenal and renal abscesses (left kidney); cerebral abscesses; chronic granuloma of the right lung.

This is an unusual infection and is probably primary in the lung.

*Comment.* The findings at autopsy probably revealed the real cause for the confusing clinical inconsistencies of a pulse rate range which at times dropped to 56 and a fever range which varied from subnormal to no more than 100 despite the

fact that the white blood cell count was consistently over 28,000 throughout the illness.

It is generally accepted that the body temperature is regulated partly by a thermostat-like control located in the region of the thalamus. Clinical observation and experimental evidence show that diseases of the brain caused by hemorrhage, tumor, meningitis or trauma are likely to be associated with rapid oscillations in the body temperature.

The auricular muscles, the sino-auricular node, the atrioventricular node and perhaps the larger part of the bundle of His are under the direct control of the cardio-inhibitory fibers of the vagus nerve whose nucleus is situated near the floor of the fourth ventricle. The rate of impulse formation in the pace-maker or lowering of the rate of impulse formation in the sino-auricular node reduces the heart rate. Increased intracranial pressure from tumor or the accumulation of exudate in the basal meninges may produce a persistent bradycardia. In such instances the pulse rate or the changes of body temperature or both, may not normally vary with changes in the degree of systemic infection.

It is believed that on a pathophysiological basis the abscesses in the region of the thalamus and the fourth ventricles disrupted the normal fever producing function of the temperature regulating center and at the same time disturbed the nucleus of the vagus causing a bradycardia. This offers a reasonable explanation of the baffling inconsistencies of a low fever and a subnormal pulse rate in a patient who had an infection of such severity as to terminate in death.

#### CONCLUSIONS

In diseases of marked chronicity in which malaise, ease of fatigue, low grade fever and loss of weight are the presenting symptoms, actinomycosis should be considered.

When any symptom complex presents inconsistencies of temperature and pulse

range wholly at variance with the obvious severity of the illness, together with vague mental symptoms, the finger of suspicion should point toward involvement of the structures of the base of the brain.

#### REFERENCES

- ATWOOD, H. S. Actinomycosis of the lung. *Northwest Med.*, 41: 419-420, 1942.
- CHRISTOPHER, F. and KARABIN, J. Abdominal actinomycosis, recovery following surgical treatment and use of zinc peroxide and sulfanilamide. *Am. J. Surg.*, 50: 371-372, 1940.
- CUTLER, E. C. and GROSS, R. E. Actinomycosis of the lung and pleura. *Am. Rev. Tuberc.*, 41: 358-367, 1940.
- DAVIS, J. M. I. Analysis of forty-six cases of actinomycosis with special reference to its etiology. *Am. J. Surg.*, 52: 447-454, 1941.
- DOWNING, JOHN G. Dermatophytosis and occupational dermatitis. *J. A. M. A.*, 125: 196-200, 1944.
- EMMONS, C. W. Actinomycosis and actinomycosis. *Puerto Rico J. Pub. Health & Trop. Med.*, 11: 63-76, 1935.
- ETTER, L. E. and SCHUMACHER, F. E. Pulmonary actinomycosis recovery after thymol therapy. *J. A. M. A.*, 113: 1023-1024, 1939.
- FRANKLIN, G. Actinomycosis: a new species, pathogenic for man. *Ann. Int. Med.*, 13: 1205-1213, 1940.
- HUTCHINSON, R. W. Actinomycosis of the lung and liver, report of a case. *U. S. Naval Med. Bull.*, 38: 325-334, 1940.
- KAPP, F. T. Pulmonary actinomycosis, case record presenting clinical problems. *Ohio State M. J.*, 38: 1036-1037, 1942.
- MARK, M. and AUERBACK, O. Generalized actinomycosis; report of a case. *Ann. Int. Med.*, 11: 537-546, 1937.
- NEIMAN, B. and FAHRNER, A. Actinomycosis of the ovary. *Am. J. Obst. & Gynec.*, 45: 534-538, 1943.
- PEMBERTON, M. A case of primary actinomycosis of the breast. *Brit. J. Surg.*, 29: 353-354, 1942.
- RANDALL, O. S. The early diagnosis and surgical treatment of actinomycosis of the head and neck. *Am. J. Surg.*, 57: 433-443, 1942.
- RISCH, O. C. Actinomycosis of the ear. *Arch. Otolaryng.*, 29: 235-251, 1939.
- SANFORD, A. and VOELKER, M. Actinomycosis in the United States. *Arch. Surg.*, 11: 809-841, 1925.
- SCHMITT, G. F. and OLSON, A. M. Actinomycosis of the thorax; report of two cases. *Proc. Staff. Meet., Mayo Clin.*, 16: 506-509, 1941.
- STEENROD, E. J. Anorectal actinomycosis. *Am. J. Surg.*, 48: 567-575, 1940.
- THOMPSON, H. and WARD, D. Cervicofacial actinomycosis treatment with surgical maggots. *J. Iowa M. Soc.*, 31: 587-589, 1941.
- THOMPSON, L. Actinobacillosis of cattle in the U.S. *J. Infect. Dis.*, 52: 223-229, 1933.
- TUTA, J. A. Pelvis actinomycosis. *Arch. Surg.*, 42: 1060-1064, 1941.
- VOSS, H. G. Actinomycosis. *J. Am. Dent. A.*, 26: 260-263, 1939.



# LONGITUDINAL FRACTURE OF THE HEAD OF THE FEMUR ASSOCIATED WITH DISLOCATION OF THE FEMUR

S. L. HAAS, M.D.

Consultant Orthopedist, Marine Hospital  
SAN FRANCISCO, CALIFORNIA

THE head of the femur is protected from direct injury because of its deep seated position in the acetabulum. When the force of impact is in direct line with the neck of the femur, it may be crushed by the impact or protruded into the acetabulum. Any force at right angles to the neck will produce a sub-capital or other type of fracture of the neck of the femur. When a dislocation of the head of the femur occurs the femoral head is rarely injured because of its firm covering of articular cartilage. The acetabular margins are frequently torn off or there may be a small chipping fracture of the head. A longitudinal fracture involving a third or more of the head is relatively rare. Little information is given in the standard textbooks on fractures and few cases are reported in the literature. Watson-Jones gives a short paragraph in his textbook on fractures. From personal communications of J. M. Murray, J. Warren White and Austin Moore, who have had one or more cases, we are inclined to believe that if a complete survey were made, a considerable number of longitudinal fractures could be gathered together and some valuable data obtained about this clinical entity.

The mechanism of the production of a longitudinal fracture is speculative and may depend on a number of factors. Usually it is associated with other injuries and due to a considerable force, as a fall from a height or automobile collision. Just why the head should split longitudinally may depend on a number of factors. The relative size of the head and its relation to the acetabulum may be important; as when the head is large and not deep seated in the acetabulum so that a considerable portion protrudes laterally from the ace-

tabulum. The relative density of the head and acetabulum, the angle of the neck with the shaft and the amount of antiversion may be influencing factors. The position of the extremity at the time of the injury, whether in adduction or abduction, internal or external rotation may be a contributing factor.

The diagnosis of a fracture in association with the dislocation can only be made from the roentgenogram, as the physical findings do not differ from those of a simple dislocation.

The prognosis for a normal functioning hip, after a longitudinal fracture with dislocation, is not very good and should be guarded. Even if the dislocation is reduced accurate apposition of the half head with the fragment in the acetabulum is difficult. If good apposition is obtained, union may not result; and even should it take place, late aseptic necrosis with dissolution of the head may occur. Furthermore, loss of strength, limitation of motion and a painful hip are possibilities.

The treatment of a longitudinal fracture of the head of the femur with dislocation is difficult because of the possibility of the previously mentioned complications. It may be treated by a closed or open operation.

Primary closed reduction should first be tried utilizing the standard procedures of simple dislocation at the hip joint. Preliminary skin or skeletal traction may be helpful. If a successful reduction with apposition of the fragments is secured, immobilization by a plaster spica is instituted until union is obtained, which may be considerably delayed because of circulatory disturbances. Because of the lack of reported cases no data can be given relative to the late results, but the possi-

bilities of aseptic necrosis must always be considered.

of the remaining part of the head and neck into the acetabulum. The decision as to which type of procedure to adopt may

If the attempt at closed reduction is not

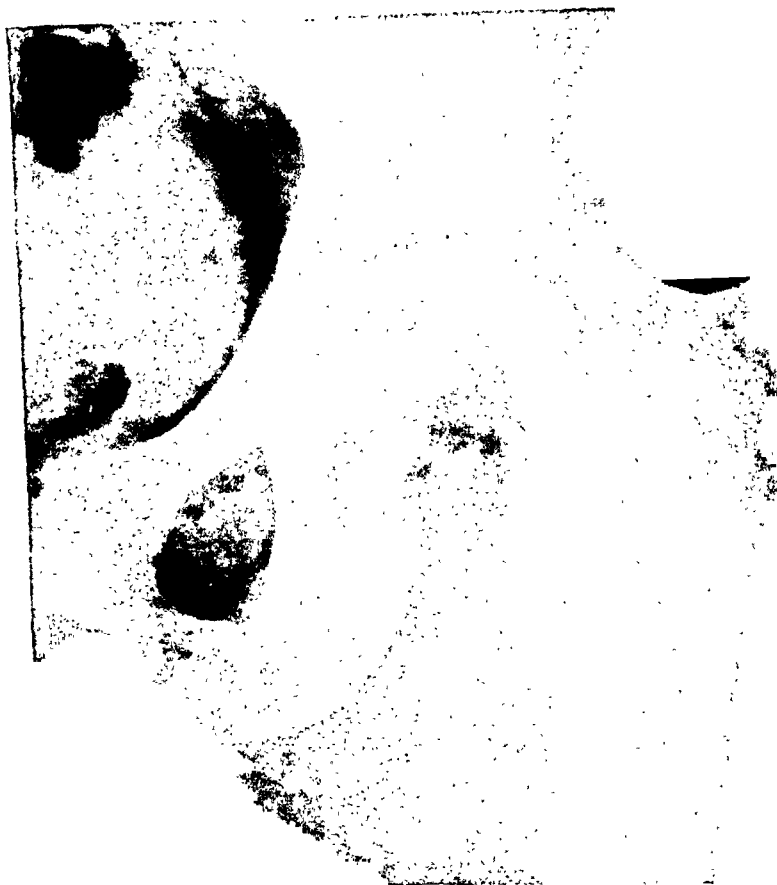


FIG. 1. Longitudinal fracture of the head of the femur with dislocation; free fragment in acetabulum. (In this instance, negative of picture has been reversed.)

successful, one must resort to open operation. Either the anterior or posterior approach may be utilized. If the posterior approach is made, one can determine more accurately the condition of the posterior rim of the acetabulum. There are four main alternative methods of treating the dislocation: (1) Reduction of the portion of the head into the acetabulum and approximating it to the remaining portion in the acetabulum; (2) reduction of the head after first removing the piece in the acetabulum; (3) removing the part of the head from the neck and after removal of the piece from the acetabulum, performing a reconstruction operation, either according to the Whitman, Colonna or Albee type of operation; (4) arthrodesis

depend on a number of factors. The age of the patient, sex, type of work to be performed, economical factors, whether one wishes only one operation, and if only one, the type that will be definitely free from the possibility of a painless extremity. Keeping in mind the previously mentioned possibilities of failure of union, of late aseptic necrosis, possibility of a painful movable hip and recurring deformity, an arthrodesis offers the best chance to obtain a satisfactory result with only one operation. If mobility is important or desired, reposition with or without approximation of the two fragments or a reconstruction operation should be performed, reserving arthrodesis for a later procedure.

The report of the history and procedure on one patient with longitudinal fracture of the head of the femur with dislocation

ous injuries aside from the one under discussion were taken care of by appropriate methods in the convalescent period. There was a shorten-



FIG. 2. After excision of the fragment from the acetabulum and reduction of the remainder of the head.

will serve as an example and bring forth some of the problems that one may encounter. It may also help to form some conclusion as to the best type of procedure to institute in the treatment of this lesion.

#### CASE REPORT

R. M., age forty-three, a roof worker, fell from a second story roof landing onto the pavement on April 16, 1943. In addition to a longitudinal fracture with dislocation of the head of the right femur, he sustained numerous other injuries which will be mentioned as they had some influence on determining the type of treatment. There was a very severely comminuted fracture of the upper end of the left tibia and fibula with displacement of the fibula and part of the tibia, fracture and dislocation of the metatarsals of the right foot, fracture and dislocation of the scaphoid of the left foot, and dislocation of the left humerus.

The patient was in fairly good condition when first seen. It suffices to say that the vari-

ing of the right extremity. The leg was in external rotation. All movements were painful. The head of the femur was felt posteriorly. The roentgenogram showed the head of the femur split in half and dislocated. (Fig. 1.) The remaining portion was in the acetabulum. There was no fracture seen about the rim of the acetabulum. An attempt to reduce the fracture dislocation of the right femur was unsuccessful. Skeletal traction was applied and after several days another attempt was made to reduce the hip but it was unsuccessful. Open operation through a posterior approach was then performed. Because of the numerous other severe injuries and the necessity of not performing too many operations it was thought best to remove the portion of the head from the acetabulum and place the remainder of the dislocated head of the femur in the acetabulum. This portion of head was difficult to maintain at the time of the operation and did not sink in like an entire head usually does when reduced. This may have been due to the lack of the cohesive force exerted by an entirely

rounded head with the smooth surface of the acetabulum. (Fig. 2.) Later check showed a redislocation of reduced half head of the femur.

A second operation was performed and in

left knee joint. If his trochanter had been transferred down or a bone lever operation been performed, he would have had greater stability of the right hip.



FIG. 3. Present condition after removal of remainder of the head and placing the neck of the femur in the acetabulum.

attempting to place the head portion in the acetabulum it broke off. Then a decision was necessary as to whether to attempt an arthrodesis or a reconstruction operation. It was thought that an arthrodesis of the hip would be preferable as it would give him a stable hip and save him from the chance of another operation. It was also thought at the time that he would have a flail knee on the opposite side. There was a failure of bony union after this operation which in view of subsequent events appears to be fortunate. (Fig. 3.) He obtained a stable knee on the opposite side with limited motion in the knee joint on the side of the dislocation. The patient is at present able to walk with a cane. He had about 40 degrees of painless flexion in the right hip with about 10 degrees abduction and practically no rotation. He has only 80 degrees of motion in the right knee joint and 30 degrees in the

#### CONCLUSION

In general in longitudinal fracture with dislocation, closed reduction should be attempted. If reduction is not successful or good apposition of the fragments is obtained, open operation is necessary. Removal of the loose piece of the head fragment from the acetabulum and then reducing the half head may be tried. It may be preferable to remove the half head attached to the neck and perform a reconstruction operation according to the method of Whitman, Colonna or Albee.

Arthrodesis should be reserved for later painful hips. If only one operation is advisable an arthrodesis may be the procedure of choice if knee joints and opposite hip are not impaired.

# FATAL PERITONITIS FROM PROCTOSALPINGOSTOMIC FISTULA COMPLICATING LYMPHOPATHIA VENEREUM\*

MAJOR ALEXANDER E. PEARCE

MEDICAL CORPS, ARMY OF THE UNITED STATES

JOHN O. BOWER, M.D. AND JOHN C. BURNS, M.D.

PHILADELPHIA, PENNSYLVANIA

THIS case is notable for the circuitous route which the lethal rectal contents took before inducing the fatal termination of the case. We have been unable to find any record of a similar episode in the literature. The comprehensive Standard Classified Nomenclatures of Disease does not list any connection between the rectum and the Fallopian tube.

## CASE REPORT

No. 5883, Mrs. M. M., a thirty-two year old negress, was admitted to the surgical service of Dr. John O. Bower at the Philadelphia General Hospital on March 29, 1939, because of diffuse abdominal pain and vomiting.

On March 24th, she developed pain in the left loin, radiating into the rectum. Despite a sensation of desire for defecation, she was unable to move her bowels. The pain persisted, she took epsom salts on that day, and diarrhea occurred on March 25th. A physician ascribed her illness to "ovarian trouble" and administered an opiate. The following day she took an enema and simultaneously passed greenish feces and vomited greenish fluid. On March 27th, she vomited once. This occurred again the following day. During this time she had eaten only small quantities of food. On March 28th, she noted blood in her urine on one occasion. Leukorrhea was persistent. Her last menstrual period, lasting one day (usual for her), had occurred two weeks before.

In 1925, she had had a right salpingo-oophorectomy and appendectomy for chronic salpingitis. In 1926, a rectal stricture was dilated at the Philadelphia General Hospital. It had produced symptoms previously for seven years. At this time the Wassermann was 4 plus and the Frei test positive. She had had typhoid

fever at the age of eight. She stated that she had experienced two previous attacks of loin pain radiating down into the rectum, one in December, 1938, and the second in February, 1939. She thought she had lost weight but was not sure of the amount.

The picture was that of an acutely ill, thin negress with slightly icteric sclerae and dyspnea. Her skin was warm and dry. Temperature 102°F., pulse 128, respirations 140, blood pressure 116/70 were noted at 11:30 A.M. on the day of admission. Her eyes were prominent, and the pupils reacted poorly to light. Oral hygiene was poor. Her tongue was dry and coated white. Heart and lungs were normal. The abdomen was markedly distended and had a midline infra-umbilical scar. Tenderness was present in the entire lower abdomen, most marked on the right. Peristalsis was absent except for an occasional tinkle over the course of the descending colon. No masses were palpable. The bladder was not distended. The liver and spleen were not enlarged. Granulation tissue was present about the urethra. Leukorrhea of moderate degree was evident. A small buttonhole in the left labium communicated with the vagina on the same side. A finger-like projection, 2 cm. in length and 1 cm. in diameter, was seen on the anterior wall of the vagina just beneath the urethra. The cervix was smooth and firm. There was no pain on moving the uterus. No adnexal masses were palpable. The anterior rectal wall was greatly indurated as high up as the fingers in the vagina could reach. Rectal examination revealed a stricture about 2 inches above the cutaneous margin. This admitted the tip of the index finger.

The provisional diagnoses were: (1) Rectal stricture due to lymphopathia venereum. (2) peritonitis—pelvic and spreading—due to pelvic

\* From the Surgical Service of Dr. John O. Bower, Philadelphia General Hospital.

inflammatory disease; (3) syphilis—site undiagnosed. (4) hypochromic anemia; (5) urethral caruncle.

On admission her hemoglobin was 49 per cent, red count 2.16, and the white cell count was 20,200 (M-8, J-14, St-62, Seg-12, L-4, Monos-8).

Perforation of the bowel was considered likely and the patient was placed on an Ochsner regime and Wangenstein suction instituted. She was given 2,450 cc. of fluid by hypodermoclysis in the first eighteen hours. On March 30th, 150 cc. of blood, 40 cc. of lyophilized convalescent peritonitis serum, and 4,250 cc. of parenteral fluids were administered. Her hemoglobin was 45 per cent, red blood count 2.10, white blood count 19,700 (M-0, J-2, St-70, Seg-6, L-12, Mono-0). Urine analysis at this time demonstrated 2 plus albumin, 2 plus leukocytes, 1 plus red cells, and granular casts. Flat plate of the abdomen on March 29th revealed a paralytic ileus with no definite evidence of obstruction. On March 31st, her blood sugar was 180 mg. (intravenous glucose given concomitantly), urea 10, plasma chlorides 646, and carbon dioxide combining power 37. On April 1st, signs of consolidation in the left base appeared. Her respirations were 50 to 65 per minute. The next day consolidations developed in the other base. Distention was unchanged and peristalsis absent. Fluids were given parenterally, only. Her temperature fluctuated between 100 and 106°F. and the pulse varied from 90 to 150. At 9:30 A.M. on April 2, 1939, she expired.

Autopsy was performed by Dr. W. Erich twenty-eight hours after death. Bilateral, moderate hydrothorax and pleural adhesions of the left upper lobe were present. Both lungs were markedly edematous and a small embolus was evident in the right lower lobe. The heart demonstrated acute toxic degeneration. There was diffuse fibrino-purulent peritonitis. Right adenexae were absent. The spleen showed moderate pulpitis. The kidney and liver revealed acute toxic degeneration. The adrenals had lipoid depletion. The pelvic veins showed thrombosis. Old adhesions of the uterus and left adnexae were present. The rectum revealed advanced lymphogranuloma with a stricture two inches above the skin margin. Careful dissection demonstrated a fistula between the left side of the rectum, just above a stricture,

and the left Fallopian tube near the ampulla (Fig. 1.) The uterine end of the tube was occluded.

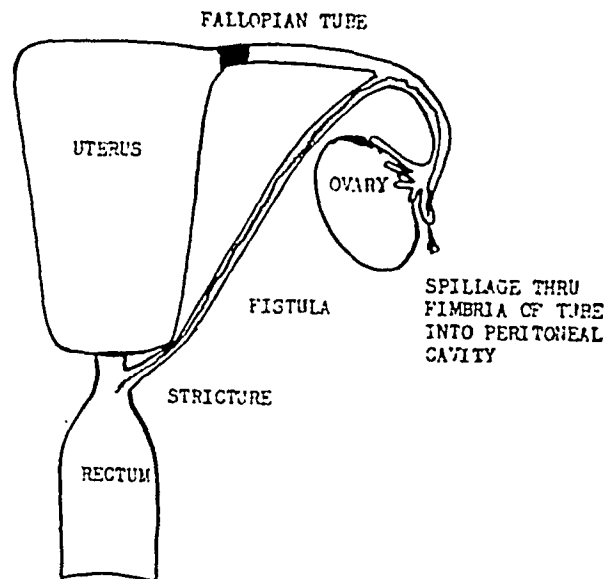


FIG. 1. Proctosalpingostomic fistula (diagrammatic) with extravasation of rectal contents through tract in left broad ligament into left Fallopian tube and into peritoneal cavity.

#### COMMENT

The concomitant presence of syphilis, gonorrhea, and lymphopathia venereum is frequently seen in clinics with a large negro clientele. The added spice of chancroid, Vincent's genital infection, granuloma venereum, venereal warts, or herpes is not uncommon. Lymphopathia is seen most in the years of greatest sexual alacrity. Its sexual distribution is about equal, but the haven of treatment for each of the sexes is different. The forlorn male with bubos is projected to the genitourinary dispensary by even the most naïve social service maiden, whereas the female is assigned to the proctologist or general surgeon for her presenting rectal symptoms. The incidence of rectal stricture has been shown to be higher in the female. In twenty series' summaries, the ratio varied from 1.4:1 to 30:1. The mean ratio is probably above 3:1. The statistics in this country have shown an overwhelming predominance in the colored race. The data of European investigators have been collected from white patients. Hayes<sup>1</sup> collected 168 cases of

which 116 were in negroes, ten in negroes, thirteen in white males, and seventeen in white females. In the majority of cases, the stricture lies between one and three inches above the anus.

A case which may have been similar was recorded by J. Couper<sup>2</sup> in 1870. He told of an autopsy in a patient with a rectal stricture of five years' duration, situated three one-half inches above the anus, "due to pus from an ovarian abscess finding its way into the rectum at (below) the seat of the stricture, and also making its escape by several sinuses running beside the bowel and opening on the buttock." No mention of a fistulous tract was made. Lancereaux,<sup>3</sup> in 1859, was the first to present the picture of pelvic inflammatory disease together with stricture of the rectum. He thought that the rectal lesion was due to syphilis and the condition in the female adnexae a manifestation of gonorrhea. It is quite likely that the latter is correct, but the proctologic lesion was more probably lymphogranulomatous. Pelvic abscess and adnexal disease have been suggested as the cause of rectal stricture by many of the older writers; but in the light of newer investigation and observations earlier in the course of the process, it would seem that both are concomitantly secondary to a primary vaginal infection if patients with co-incidental gonorrheal pelvic disease are excluded. The affliction once so common among Mediterranean sailors who practiced pederasty may well have been primarily proctologic, though, Ravaut, Senèque, and Cachera<sup>4</sup> described patients

with rectal stricture and chronic salpingo-perimetritis, with or without vulvovaginal disease. Stannus<sup>5</sup> believed that a spreading pelvic cellulitis is part of the picture. David and Laurer<sup>6</sup> stated that laparotomy in some of the cases never revealed evidence of pelvic gland involvement. This is incompatible with the evidence showing the primary lesion in the vagina with later perirectal involvement by lymphatics from the lower part of the posterior vaginal plexus which run backward and pierce the rectal fascia. Therefore, the pathological process in the rectum then spreads toward the mucosa.

We believe that this presentation demonstrates the connection between lymphopathic disease of the rectum and its manifestations in the internal female genitalia. The production of a sinus tract from the stricture site in the rectum through the perirectal tissue and the broad ligament into the left Fallopian tube is a unique illustration of the manifold suppurative and fibroblastic components so characteristic of the disease.

#### REFERENCES

1. HAYES, H. T. Stricture of the rectum. *Tr. Am. Proct. Soc.*, 32: 325-326, 1931.
2. COUPER, J. Non-malignant strictures of the rectum. *Tr. Path. Soc. London*, 21: 190, 1870.
3. LANCEREAUX. Cas de retrecissement syphilitique du rectum. *Bull. Soc. Anat. Paris*, p. 100, 1859.
4. RAVAUT, P., SENEQUE, J. and CACHERA, RENE. Salpingo-perimetritis with rectal stricture. *Bull. Soc. Franç. Dermat. et Syph.*, 38: 1450, 1931.
5. STANNUS, H. S. A Sixth Venereal Disease. London, 1933. Balliere, Tindall and Cox.
6. DAVID, V. C. and LAURER, C. A. Rectal stricture. *J. A. M. A.*, 98: 1, 1932; 98: 499, 1932.



# STAB WOUND OF THE HEART

## SUCCESSFUL REPAIR OF A LACERATION OF THE HEART IN A PATIENT WITH AORTIC REGURGITATION AND MARKED CARDIAC HYPERTROPHY

J. HERSH, M.D.

Associate in General Surgery, Passavant Hospital  
PITTSBURGH, PENNSYLVANIA

**S**TAB wounds of the heart if not immediately fatal are offered a fair chance of recovery by prompt surgical in-

### CASE REPORT

L. F., case No. 2217, a negro male, age twenty-three years, was admitted to the emer-



FIG. 1. Eight days postoperatively reveals a marked enlargement of the cardiac shadow suggesting pericardial effusion.

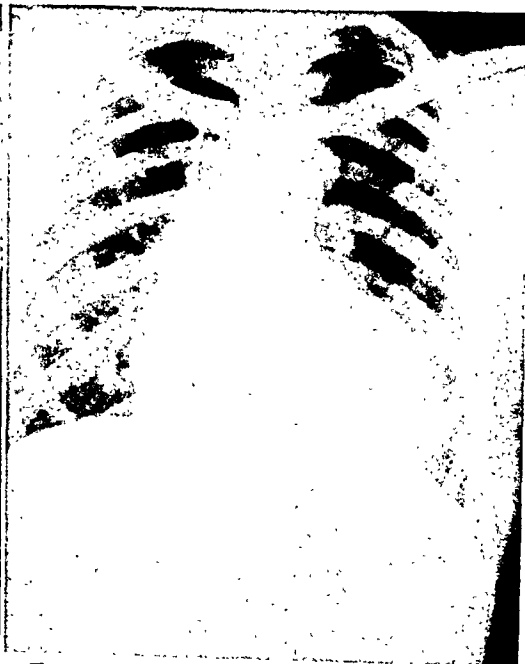


FIG. 2. Fifteen days postoperatively reveals some diminution in size of the cardiac shadow.

tervention. Elkin in a series of forty-five patients with heart wounds had twenty-nine operative recoveries, none of whom had any residual symptoms referable to the injury. Bigger in a series of forty-five cases had twenty recoveries out of twenty-nine operative cases.

A rapid approach giving excellent exposure to the heart and pericardium, as well as the pleural cavity is obtained by an intercostal incision, the site depending upon the wound of entry and supplemented by division of one or more costal cartilages close to the sternum.

gency room of the Passavant Hospital at 11:55 P.M. on April 7, 1944, shortly after being stabbed in the left chest with a pocket knife.

A sucking wound was present in the sixth interspace about two inches lateral to the left sternal border. His clothes were bloodsoaked and radial pulse and blood pressure were unobtainable. An intravenous infusion of 5 per cent glucose in saline solution was started and the patient taken to the operating room.

Under local infiltration anesthesia the knife wound was débrided and the incision extended along the sixth interspace with section of the fifth, sixth and seventh costal cartilages close to the sternum. A hemothorax was encountered



and emptied by mechanical suction. A spurting laceration of the heart muscle, near the apex was closed with two interrupted black silk

charge twenty-eight days after his injury. An x-ray examination taken on his discharge (Fig. 3) demonstrated "a marked enlargement



FIG. 3. Examination on discharge, twenty-eight days postoperatively reveals cardiac enlargement suggestive of an aortic regurgitation.

sutures and the rent in the pericardial sac was loosely closed with four interrupted black silk sutures. Five Gm. of sulfanilamide powder was sprinkled into the pleural cavity and the chest wall closed without drainage.

The patient was returned to the ward in good condition and sulfadiazine, Gm. 1, administered every four hours for ten days.

On April 15, 1944, a chest x-ray (Fig. 1) revealed "a marked enlargement of the cardiac shadow. The contour suggests fluid in the pericardium." At this time he had been complaining of a full feeling in his chest, labored respirations and dyspnea. The costoxiphoid route was chosen for pericardial aspiration and 25 cc. of straw colored fluid was obtained. In spite of this small amount of aspirated fluid he made a dramatic improvement.

On April 22, 1944, a second x-ray examination (Fig. 2) reported "the size of the cardiac shadow is considerably reduced since the last examination. It is possible there may still be a small amount of fluid in the pericardium." His temperature reached normal on the twelfth day and he continued to improve until his dis-

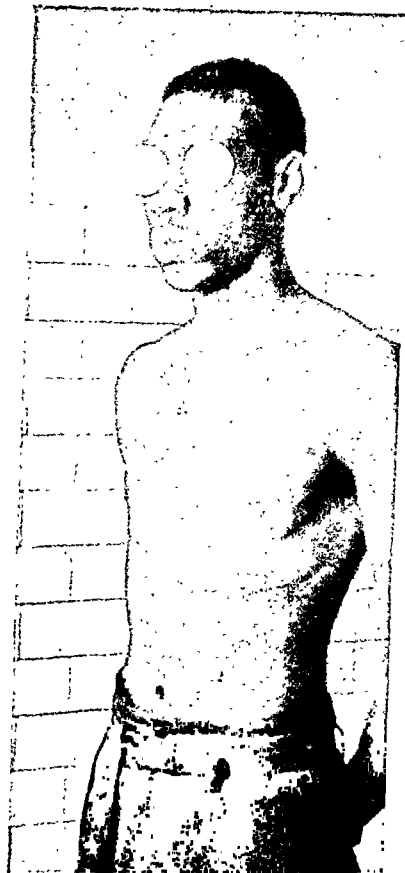


FIG. 4. Patient on discharge from hospital.

of the cardiac shadow. The left border extends out almost to the chest wall. The contour does not indicate the presence of a pericardial effusion at this time. The enlargement is mostly in the region of the left ventricle and would indicate the presence of an aortic regurgitation."

This patient's past medical history revealed an attack of rheumatic fever at fourteen years of age and anti-syphilitic treatment for some time prior to his hospital admission. On physical examination the characteristic signs of aortic regurgitation were present. The cor bovinum of aortic regurgitation made an excellent target for a knife thrust at the left chest wall. His prompt recovery and return to his former occupation without any signs or symptoms referable to his accident attests to the ability of even the heart scarred by disease to withstand surgery due to penetrating trauma.

# AUTHOR INDEX TO VOLUME LXIX

Anderson, Roger, 299  
Arkin, A. M., 133

Bailey, Hugh A., 253  
Bancroft, Frederic W., 236  
Barber, Robert F., 138  
Barnes, T. Cunliffe, 82  
Barrett, Channing W., 258  
Barrett, Russell A., 258  
Beal, John M., 236  
Behan, R. J., 227  
Beneventi, Francis A., 224  
Benson, Raymond E., 384  
Berman, Edgar, 120  
Blain, Alexander W., 160  
Bond, Lula, 89  
Bower, John O., 406  
Brodie, Nathan, 243  
Burns, John C., 406

Carruthers, F. Walter, 39  
Carty, James B., 372  
Cohen, Harold, 135  
Cohen, Samuel E., 155  
Coles, Jerome S., 366  
Colonna, Paul C., 281  
Cunningham, John J., 155  
Cunningham, John R., 155

Davis, Joseph B., 4  
DeMatteis, Albert, 160  
De Nicola, R. Robert, 138  
Dickinson, Arthur M., 9  
D'Ingianni, Vincente, 137  
Dixon, Claude F., 384  
Downing, Wendell, 260

Eger, Sherman A., 372  
Eisenstodt, Lester W., 168  
Erickson, Herbert R., 299

Fett, H. C., 283  
Ficarra, Bernard J., 234, 325  
Foote, R. F., 283  
Fox, Paul F., 135

Garland, James G., 17  
Goldman, Charles, 265

Haas, S. L., 402  
Haber, Josef J., 253  
Harris, C. M., 391  
Hersh, J., 409  
Hubbard, Roger S., 204  
Hyde, Theodore L., 73, 182

Karnaky, Karl John, 107  
Kasten, Harry E., 397  
Kaufman, Justus, 129, 221  
Kern, Howard M., 120  
Kickham, Charles J. E., 249  
Kornfield, N. B., 177

Lamberti, Thomas G., 204  
Lamont, Edward S., 144  
Lawler, Richard H., 135  
Lee, Harold G., 213  
Leonard, Donald W., 344  
Leviton, L. R., 391  
Lifton, Jacob C., 318

MacAusland, W. Russell, 213  
Mair, George B., 352  
Marshall, Wallace, 338

Martin, E. G., 272  
Mathesheimer, J. L., 230  
McElvenny, Robert T., 94  
McQuillan, Arthur S., 318  
Moorhead, John J., 306

Naclerio, Emil A., 325  
Neter, Erwin, 204  
Novak, Emil, 1

Pearce, Alexander E., 406  
Phaneuf, Louis E., 141  
Pick, John F., 25  
Pilcher, Lewis S., 190  
Pizzi, Frederick A., 274

Rabinowitz, Harris M., 66  
Reibstein, Nathan, 66  
Rosenblatt, Millard S., 232

Sampolinski, A., 262  
Shallow, Thomas A., 372  
Spivack, Julius L., 47  
Spotts, S. Dale, 4  
Stanton, Richard H., 249  
Star, Leon D., 270  
Stevens, M. A. L., 283

Thoroughman, J. C., 238  
Traver, Clarence A., 9

Vallone, John J., 126

Waters, Edward G., 208  
Waugh, Richey L., 89  
Wenzel, J. F., 272  
Wilensky, Abraham O., 116  
Winter, Leo, 318

# SUBJECT INDEX TO VOLUME LXIX

(Bo.B.) = Bookshelf Browsing; (E.) = Editorial

**A** bdomen, pendulous, 262

Abuse of cesarean section, 208

Acetabulum

fractures of, 213

protrusion of, 238

Actinomycosis of lung, 397

Adamantinoïa, removal of, 318

Allantoin-sulfanilamide ointment in surgery, 4

American surgery (Bo.B.), 274

Anesthesia, pentothal, continuous, 177

Aneurysm, dissecting, of thoracic aorta, 344

Aorta, thoracic, aneurysm of, 344

Appendectomy, contamination of wound during, 234

Application of tourniquet, 94

Aspects, psychological, of gynecological practice (E.), 1

Atony, persistent, and hemorrhage, 66

**B**asis, working, for head injuries, 73

Bladder herniation and kidney stone, 258

Blood serum injections and skin lesions, 338

Bodies, foreign, and electromagnetic locator, 306

✓ Bone tumors, malignant (E.), 281

Boy, isolated myeloma in, 129

Brain involvement in actinomycosis of lung, 397

Breast

cancer of, 17

carcinoma of, 236

Burns, grafting of skin for, 168

**C**ancer of breast, 17

Carcinoma

of breast and pathological fractures, 236

of uterine cervix (E.), 141

squamous cell, of renal pelvis, 249

Carotid body tumors, 9

Cast, glass plastic, 299

Cervix, uterine, carcinoma of (E.), 141

Cesarean section, use and abuse of, 208

Childhood, inguinal hernia in, 366

Clamp, peritoneal, 138

Contamination of wound during appendectomy, 234

Cotton sutures and disruption of wound, 137

Crisis in thyroid, 325

Cure, operative, of inguinal hernia, 366

Cysts, urachal, infected, 243

**D**ermoplasty of war wounds of leg, 25

Diagnosis of bone tumors (E.), 281

Disease

malignant, of small intestine, 372

Paget's, of nipple, 221

pilonidal, treatment of, 230

Dislocation

fracture, of cervical vertebrae, 270

of femur, 402

Disruption of wound, 137

Douches, normal, 107

**E**mbodiment of vitallium mandibular prosthesis, 318

Embolism, pulmonary, 190

Embolus, liver, and hemorrhoidectomy, 272

Ethyl alcohol, intravenous, as postoperative sedative, 227

Evolution of gastrostomy, 47

Explosions in operating room, 89

Extirpation of uterus in atony and hemorrhage, 66

**F**emale, normal douches for, 107

Femur, fracture of head of, 402

Fibromyoma, nummiform, of nipples, 155

Fibrosarcoma, primary, of great omentum, 135

Fistula, proctosalingostomic, 406

Fracture

dislocation of cervical vertebrae, 270

longitudinal, of head of femur, 402

Fractures

delayed union and non-union of, 283

nasal, surgery of, 144

of acetabulum, 213

of pelvis, 39

pathological, and carcinoma of breast, 236

**G**angrene, gas, treatment of, 391

Gastrostomy, evolution of, 47

Glass plastic cast, 299

Goiter, substernal and intrathoracic, 160

Grafting of skin in burned patients, 168

Grafts, skin, for hernias, 352

Gynecology, aspects of, in practice (E.), 1

**H**ead

injuries to, 73

of femur, fracture of, 402

Healing

of pathological fractures through metastases, 236

rate of skin, 82

Heart, stab wound of, 409

Hemangioma of tendon, 133  
 Hemorrhage, postpartum, 66  
 Hemorrhoidectomy and liver embolus, 272  
 Hernia  
   inguinal, cure of, 366  
   supravesical, 260  
   suturing of, with skin grafts, 352  
 Herniation, bladder, 258  
 Herniorrhaphy, inguinal, 182  
 Hypertrophy, cardiac, 409

**I**nfancy, inguinal hernia in, 366

Injections of blood serum and skin lesions, 338  
 Injuries to head, 73  
 Intestine, small, malignancy of, 372

**K**idney

  involvement in actinomycosis of lung, 397  
   stone in, 258

**L**eg, wounds of, and dermoplasty, 25

Lesions of skin, fibromatous, 338  
 Ligation of vena cava for thrombophlebitis, 120  
 Liver

  embolus and hemorrhoidectomy, 272  
   extracts for skin healing, 82  
   tests, value of, 116

Locator, electromagnetic, 306

Lung

  actinomycosis of, 397  
   embolism in, 190

Lymphopathia venereum, 406

**M**alignancy

  multiple, primary, 265  
   of small intestine, 372

Management

  of carcinoma of uterine cervix (E.), 141  
   surgical, of goiter, 160  
   of tumors of neck, 384

Mandible, prosthesis for, 318

Megacolon, 253

Men, young, pyuria in, 224

Metastases from carcinoma of breast, 236

Method, ambulant, for pilonidal disease, 230

Myeloma, isolated, in boy, 129

**N**eck, tumors of, 384

Nipple

  fibromyoma of, 155  
   Paget's disease of, 221

Non-union of fractures, 283

Nose, plastic surgery of, 144

**O**intment, allantoin-sulfanilamide, 4

Omentum, great, fibrosarcoma of, 135

Operating room explosions, 89

Operation for adamantinoma, 318

Origin, hepatic, of thyroid crisis, 325

**P**aget's disease of nipple, 221

Papilloma mamillae, 155

Patients, burned, and skin grafting, 168

Pelvis

  fractures of, 39

  renal, carcinoma of, 249

Penicillin

  efficacy of, 204

  for gas gangrene, 391

Pentothal anesthesia, continuous, technic of, 177

Peritoneum, clamp for, 138

Peritonitis, fatal, and proctosalpingostomic fistula, 406

Petrolatum for skin healing, 82

Plastic surgery of nasal fractures, 144

Practice of gynecology (E.), 1

Prevention of wound contamination, 234

Problem

  of delayed union of fractures, 283

  of malignant bone tumors (E.), 281

Protrusion, intrapelvic, of acetabuli, 238

Pulse, abnormal, in actinomycosis of lung, 397

Pyuria, asymptomatic, 224

**R**eductions, functional, of fractures of pelvis, 39

Regurgitation, aortic, 409

Repair of laceration of heart, 409

Room, operating, explosions in, 89

**S**edative, postoperative, ethyl alcohol as, 227

Skin

  grafting in burned patients, 168

  grafts, whole, for hernias, 352

  healing rate of, 82

  lesions, fibromatous, and blood serum injections, 338

Stab wound of heart, 409

Stone in kidney, 258

Streptococcus, hemolytic, in wounds, 204

Streptothricin, efficacy of, 204

Sulfathiazole, efficacy of, 204

Surgery

  allantoin-sulfanilamide ointment in, 4

  American (Bo.B.), 274

  of goiter, 160

  of nasal fractures, 144

  of pendulous abdomen, 262

Sutures

  cotton, and disruption of wound, 137

  fascial, and skin grafts, 352

- T**echnic of continuous pentothal anesthesia, 177
- Temperature, abnormal, in actinomycosis of lung, 397
- Tendon, hemangioma of, 133
- Testicle, undescended, 232
- Tests, liver, value of, 116
- Thrombophlebitis, pneumonic, 120
- Thyroid crisis, 325
- Tourniquet, 94
- Trauma and aneurysm, 344
- Treatment
- of gas gangrene, 391
  - of head injuries, 73
  - of hernias, 352
  - of megacolon, 253
  - of pilonidal disease, 230
  - of pulmonary embolism, 190
  - of skin with petrolatum, petrolatum containing yeast and liver extracts, 82
- Tumors
- of bone (E.), 281
  - of carotid body, 9
  - of neck, 384
- Tyrothricin, efficacy of, 204
- U**nion, delayed, of fractures, 283
- Urachus, cysts of, 243
- Use of cesarean section, 208
- Uterus
- double, 126
  - extirpation of, 66
- V**alue of functional liver tests, 116
- Vena cava, inferior, ligation of, 120
- Vertebrae, cervical, dislocation of, 270
- Vitallium prosthesis for mandible, 318
- W**ar wounds of leg, 25
- Wound
- contamination during appendectomy, 234
  - disruption with cotton sutures, 137
  - stab, of heart, 409
- Wounds
- hemolytic streptococcus in, 204
  - of leg and dermoplasty, 25

